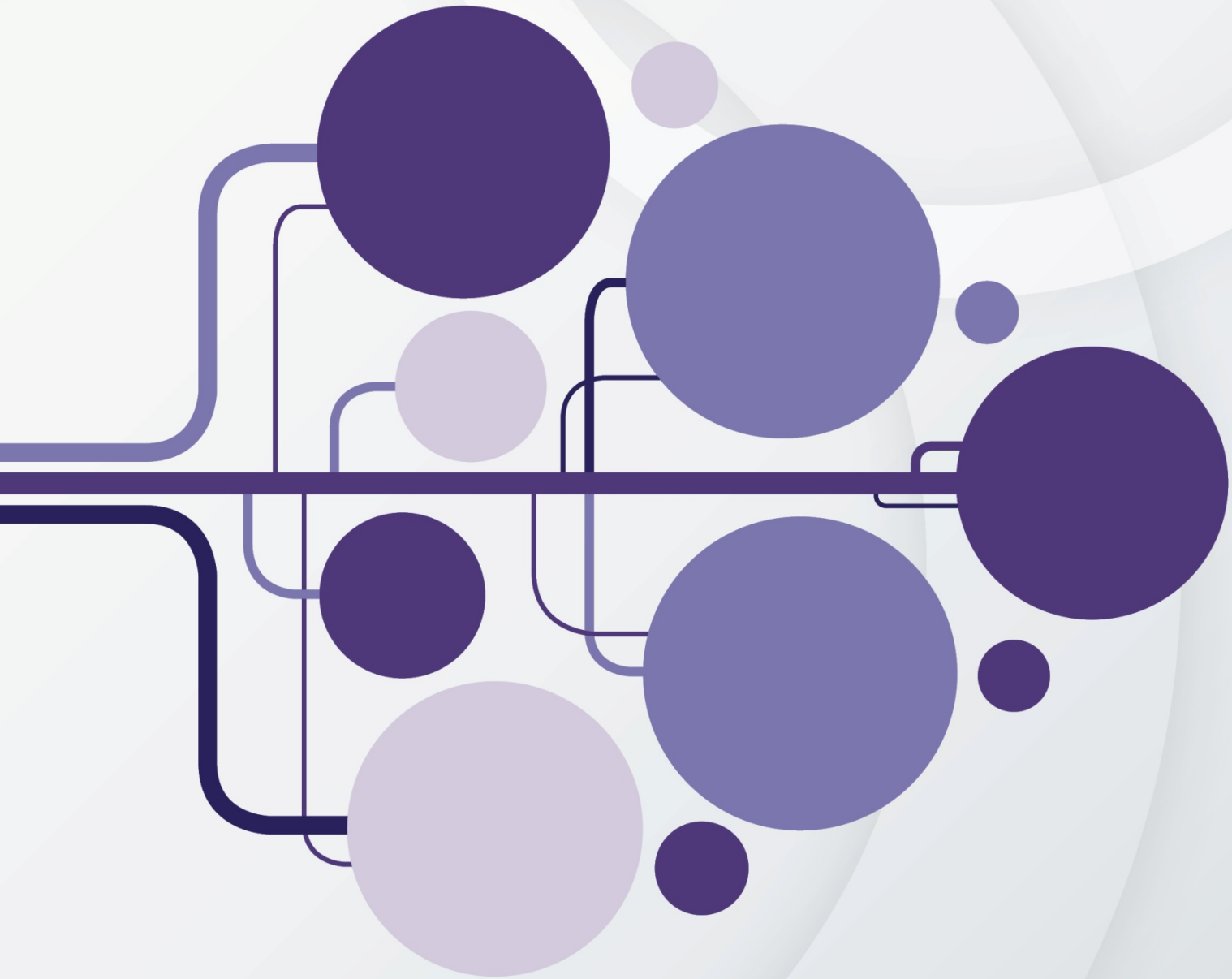
Tekscan

# ELF™ USER MANUAL

## Single Handle, Multi-Handle, Wireless, and Hi-Speed Systems v. 4.3x (Rev N)



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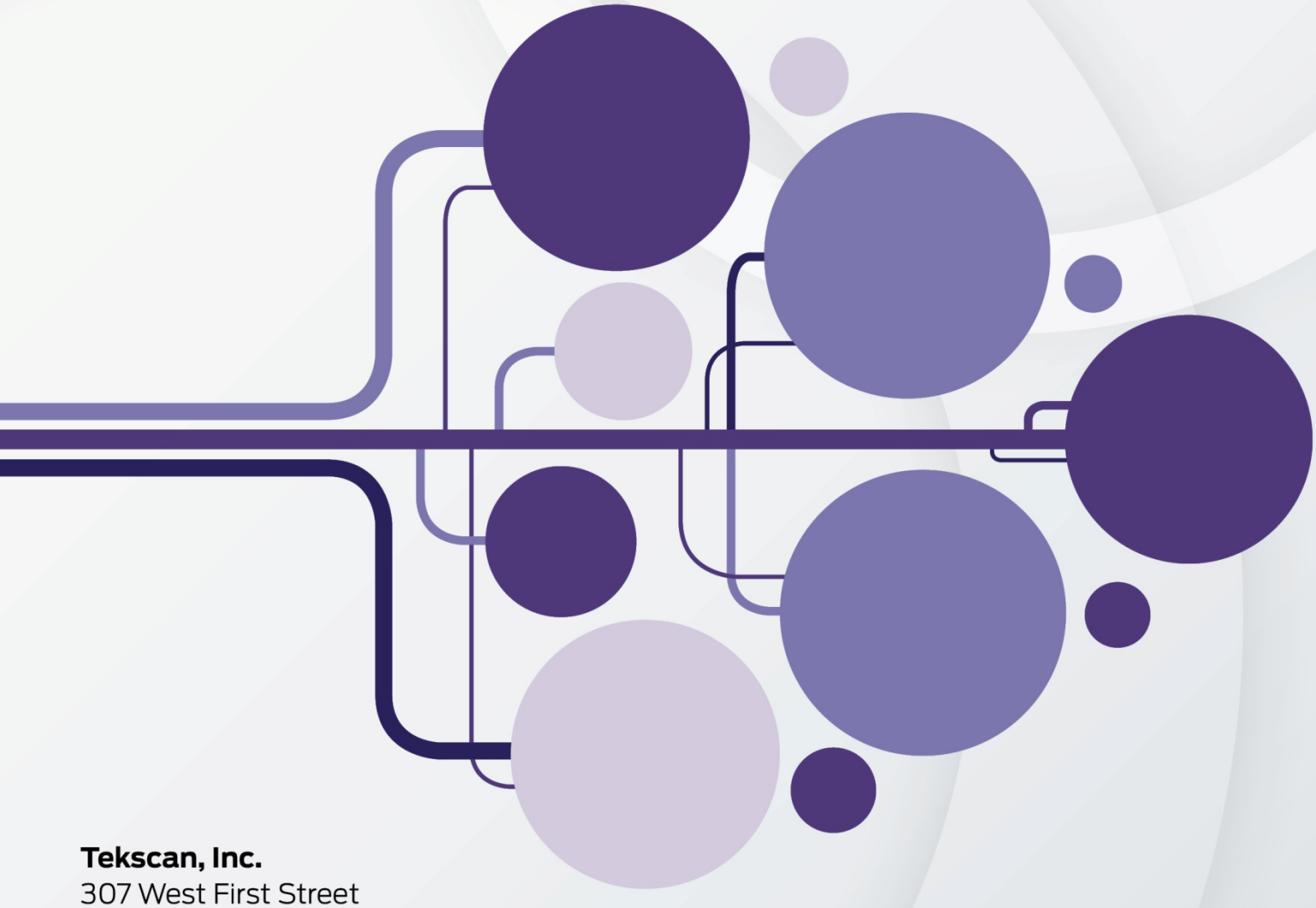

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# WELCOME

# ISO

Tekscan is registered to the following standard(s):

- ISO 9001: 2000
- ISO 13485: 2003

# Introduction

This manual describes how to use Tekscan's Economical Load & Force (ELF™), Multi-Handle ELF, and Hi-Speed ELF systems. These systems are ideal for designers, researchers, or anyone who needs to measure forces without disturbing the dynamics of their tests. The FlexiForce® sensors can be used to measure both static and dynamic forces (up to 1000 lbf.), and are thin enough to enable non-intrusive measurement. Each ELF system is comprised of FlexiForce's Microsoft (MS) Windows-based software, the associated electronics, and FlexiForce sensors. The ELF system hardware includes the sensor handle with USB adapter and the sensors. One of the major advantages of this system is that it is simple to install, and requires very little hardware.

The ELF sensors use a resistive-based technology. The application of a force to the active sensing area of the sensor results in a change in the resistance of the sensing element in inverse proportion to the force applied. After a simple calibration is performed, this force can be displayed on the screen in the measurement units that you choose, such as Pounds or Newtons.

The ELF software is an 8-bit application that is compatible with Microsoft (MS) Windows 2000/XP/Vista. The software allows you to view a graphical representation of the force on the sensor in real-time, record this information as a "movie," and review and analyze it later. There are a number of options for displaying the real-time force data; it can be displayed as a "strip chart," "column graph," or "digital readout." Recorded "movie frames" can be saved as ASCII (text) files, which can be imported into a spreadsheet program, or opened in a text editor or word processing program. Real-time data or movie frames can also be copied to the Windows clipboard and pasted into other applications as a **.bmp** (bitmap) file.

# Getting Assistance

**Tekscan, Inc.** will provide technical assistance for any difficulties you may experience using your ELF system.

Write, call or fax us with any concerns or questions. Our knowledgeable support staff will be happy to help you. Comments and suggestions are always welcome.


**Tekscan, Inc.**
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Tekscan, Inc. makes no representation or warranties with respect to this manual. Further, Tekscan, Inc. reserves the right to make changes in the specifications of the product described within this manual at any time without notice and without obligation to notify any person of such revision or changes.

FlexiForce and ELF are registered trademarks of Tekscan, Inc.

***Windows 2000/XP/Vista***, ***MS-DOS***, ***Word***, ***Notepad***, and ***Excel*** are registered trademarks of Microsoft Corporation.

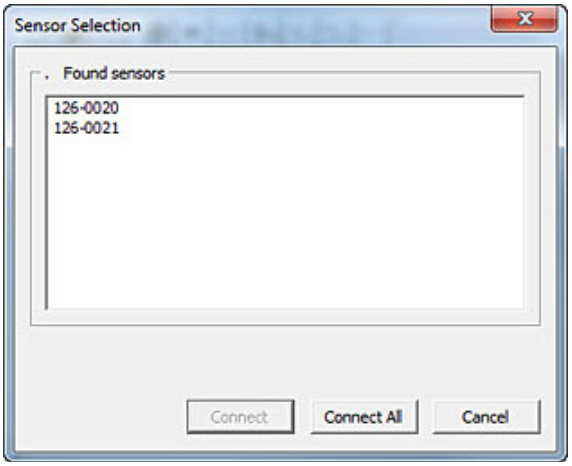
# Quick Start

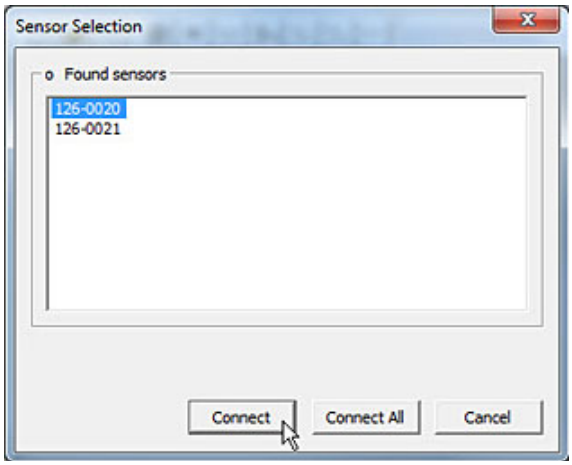
This is a quick look at how to use your ELF system. This Quick Start procedure should be followed as a general outline; it will give you the basics on how to view sensor force data in a Real-time Window, record this data, play the recording back, and analyze the data. However, you must read the entire manual before designing your application. If you are using the Wireless ELF (WELF) system, please refer to The Wireless ELF System section.

***Note: This procedure assumes that the ELF software has been successfully installed on your system. In addition, a familiarity with MS Windows is assumed.***

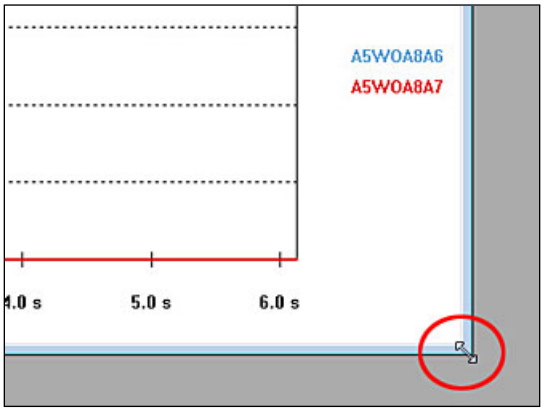
1. Make sure the sensors are inserted correctly into the handles. Run the program by clicking the **Start** button at the bottom left of the screen, selecting **Programs**, and then clicking the **ELF Multi** icon (shown at right).

2. The “Sensor Selection” window is displayed on your computer screen (shown below left). Select the sensors you would like to have connected to the current Real-Time Window (using **Ctrl+Click** to select multiple sensors), and click the **Connect** button (shown below right). If you wish to connect to all sensors, you do not have to first select any sensors. Simply click the **Connect All** button. See the Sensor Selection section for more information about this dialog.

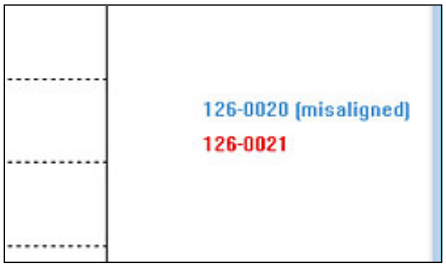


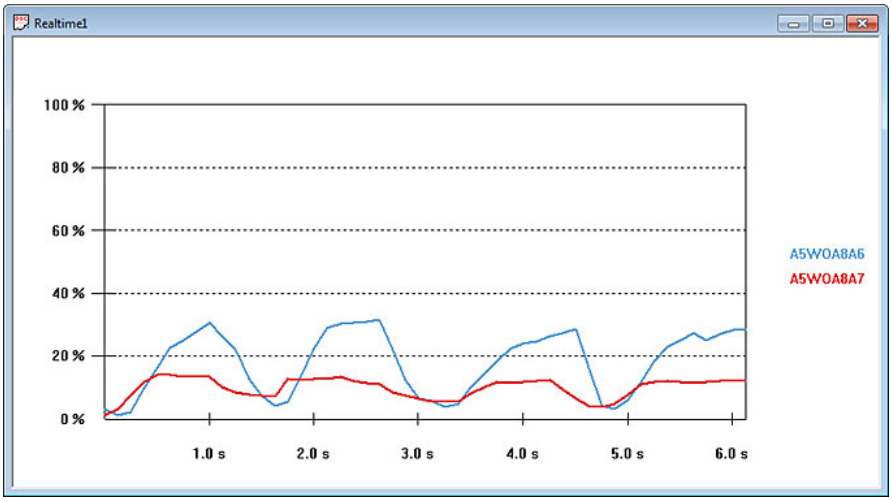
3. A new Real-time window appears. The size of this window will vary, since MS Windows cascades new windows. If the window is too small to view comfortably, enlarge it by dragging an edge of the window with the cursor (shown below).



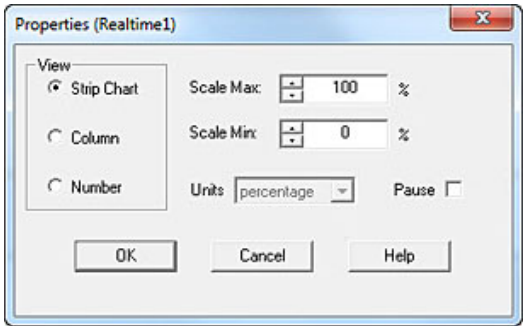

If the sensor is misaligned in the Handle, the label indicates the misalignment (shown below). Remove and reinsert the sensor into the Handle to ensure it is working correctly. If the sensor is inserted properly into the Handle, and the software still indicates it is misaligned, contact Tekscan for assistance.



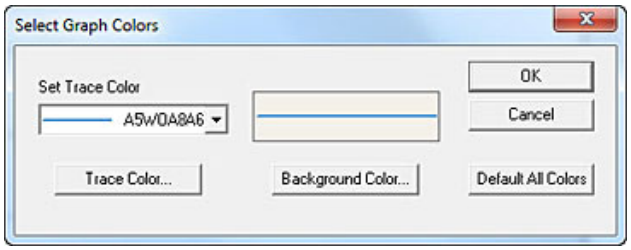

4. Apply the test force to the sensing area of the sensors (refer to the Sensor Loading Considerations section and ensure that the sensors are conditioned before use). The force data will be displayed in the window in the default mode, which is as a "Strip Chart". This shows the data in the form of a chart, with elapsed time (in seconds) on the X-axis, and the selected units (default is "percentage") on the Y-axis.



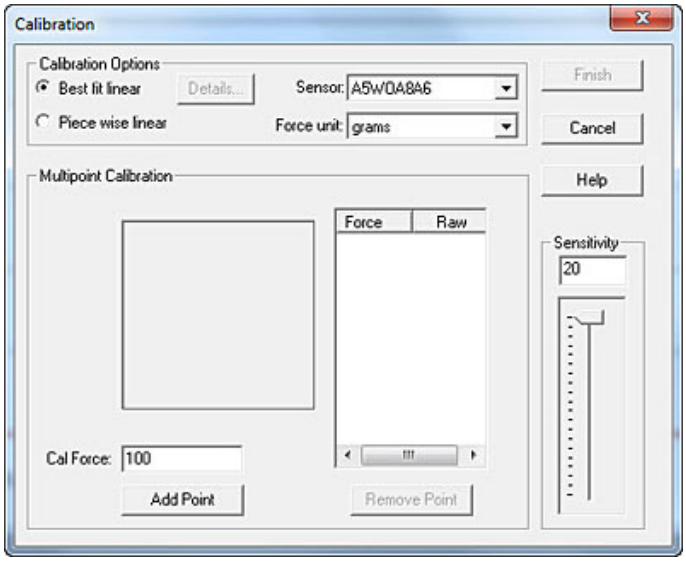
5. Click on **View > Properties** (or click the right mouse button with the cursor over the Real-time Window) to open the *Properties* dialog box. Make any desired changes to the display settings, and click **OK**.



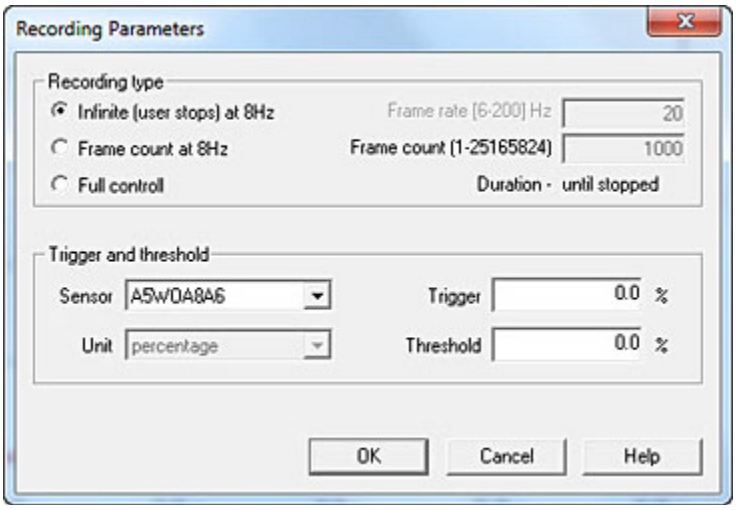

6. If you would like to change the background color of the window, select **Tools > Select Colors**. The *Select Graph Colors* dialog box will open, and enable you to customize the background color.



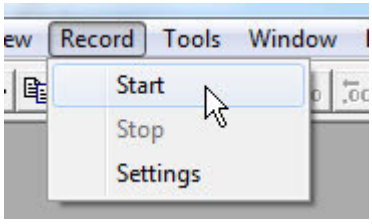

7. Calibrate the sensor(s), so that an actual force range can be determined for the sensor's digital output (0 to 255). Refer to the Calibration section for the calibration procedure and guidelines. It is also recommended that you perform a "Sensitivity Adjustment", which is described in the "Calibration" section.

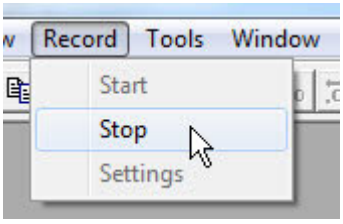


8. Select the desired recording parameters under **Record > Settings**. The default **Recording Type** is "Infinite (user stops) at 8Hz," but you are given the option to stop the recording after a specific number of frames. You may also set recording frequency, trigger and threshold, as well as frames to record, in this dialog box.

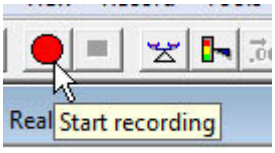


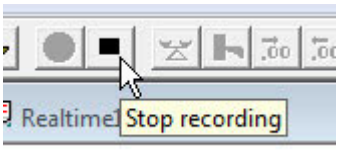

9. Click **Record > Start** (or the **Start Recording** icon on the Toolbar). The system will begin recording data. If you selected "Infinite (8 Hz, user stops)" as the recording type, you must click **Record > Stop** (or the **Stop Recording** icon on the Toolbar) to stop recording. Otherwise, recording will stop when the required number of frames have been acquired.



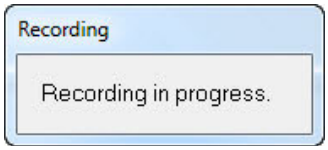




An alternate method of Starting and Stopping the recording is found on the Toolbar using the Icons, as shown below:



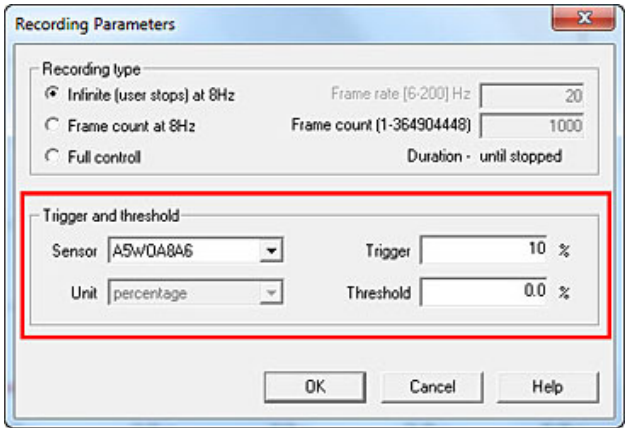




A Recording in Progress prompt opens on-screen to indicate a recording is taking place (shown below)

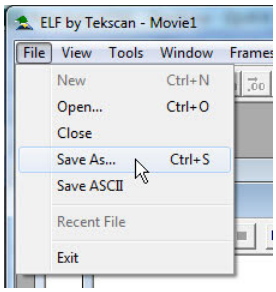


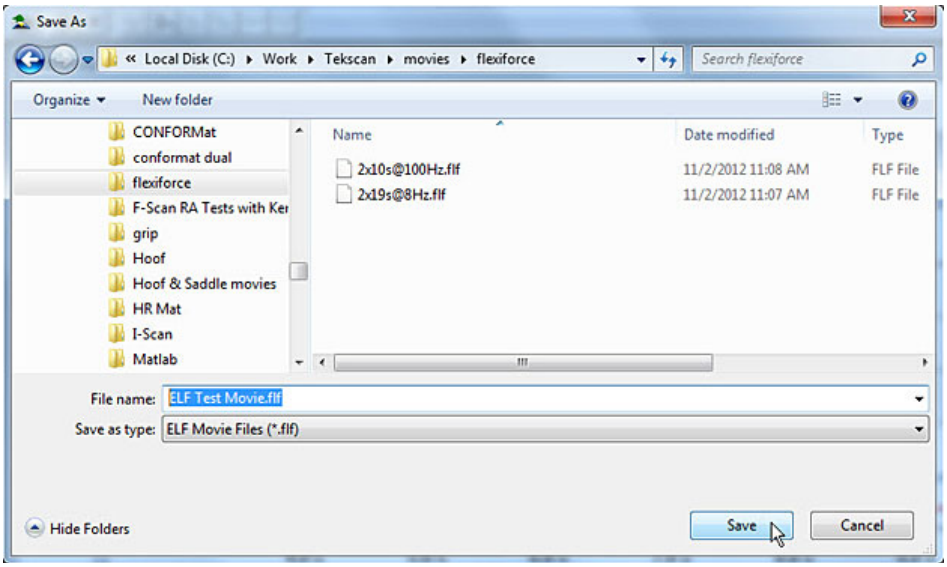
***Note: Before an actual recording is made, the sensor should be Calibrated and Conditioned, and a Sensitivity Adjustment should be done (if necessary), as described in later sections. Any information recorded before these are successfully completed may be inaccurate.***

The ELF software also allows you to trigger the start of a recording. If you enter a value in the **Trigger Force** field under **Record > Settings**, recording will not begin until that force is exerted on the sensor. Force threshold may be selected for each sensor, so that a recording will not begin until the force reaches the threshold. See the Calibration section for more details.

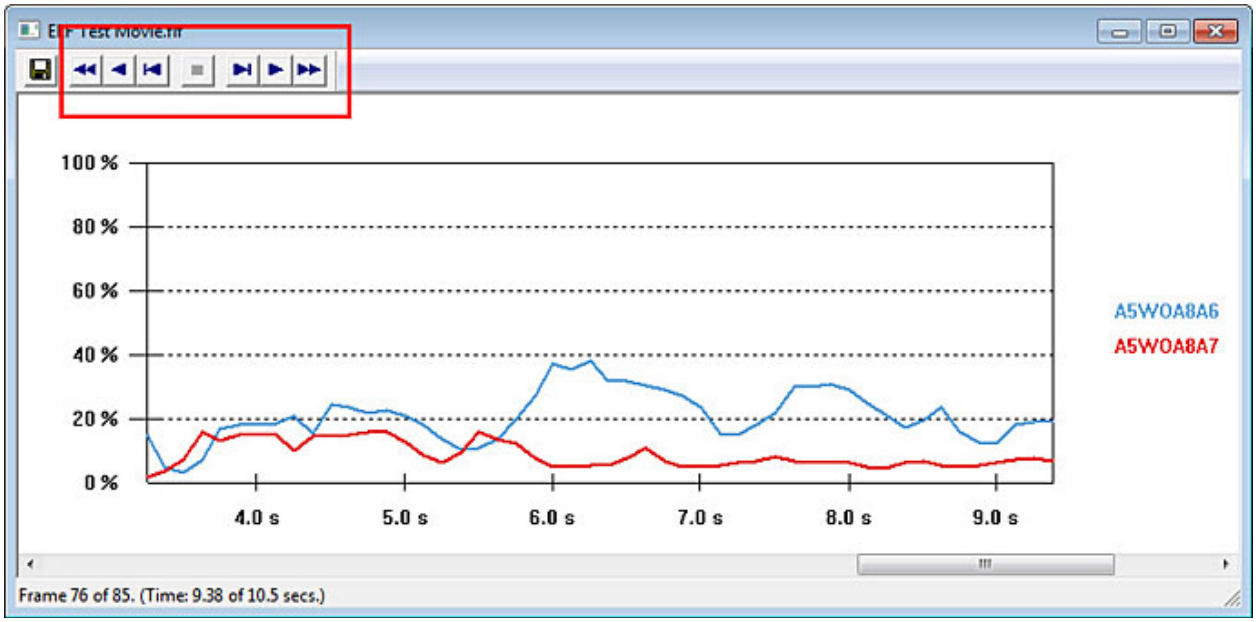



10. Select **File > Save As** to save the movie. Under **File Name**, enter the desired file name (e.g.: "**test1.flf**") and select the destination (path) where you want to save your recording. Recordings must be saved as ELF Movie Files (with the extension ***.flf**).

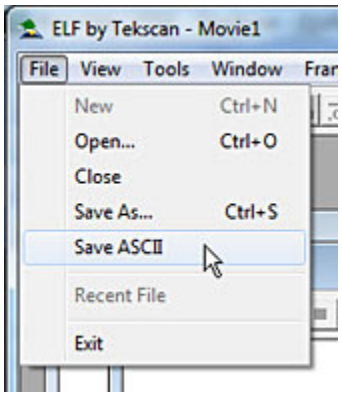


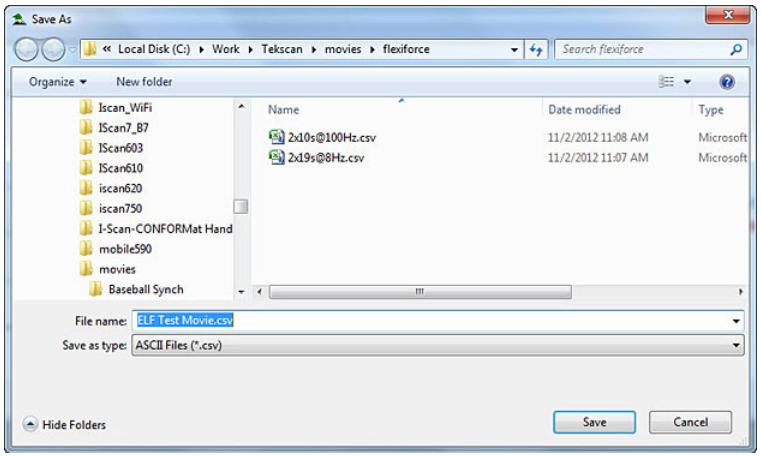



11. Click on one of the **Playback Control** icons on the toolbar at the top of the Movie window to play the movie forward or backward, move one frame forward or backward, move to the first or last frame, or stop the movie.




12. Select **File > Save ASCII** to save the movie data as a text file. ASCII files must be saved with the extension ***.csv.** This data can then be viewed by importing it into a spreadsheet program, such as MS Excel, or by opening the text file in a word processing program, such as MS Word.




***You have now completed the Quick Start section, and should be acquainted with your ELF software. The rest of the manual gives you specific instructions on how to set up and run your system.***

# INSTALLATION

For the ELF software to function properly, your system must have the following minimum requirements:

- Pentium 300 MHz
- 64 MB RAM
- 5 MB of Hard Drive Space
- CD Drive
- One USB 2.0 port per USB Handle
- Windows 2000/XP/Vista

To use the Multi-Handle ELF software with multiple USB Handles, one USB 2.0 port must be available for each ELF Handle used. If you require a USB hub, Tekscan recommends the following:

Belkin: USB Plus Hub (7 Ports) ($49.99)
Hi-Speed USB 2.0 7-Port Hub
http://www.belkin.com/
Model # F5U307

IOGEAR ($29.95)
MiniHub
4-port USB 2.0 Hub
http://www.iogear.com/
Model # GUH264

***The following displays the ELF system with USB Handles.***

***Note: Our previous systems shipped with Serial handles. It is not recommended to use both the Serial ELF and USB ELF handles simultaneously.***

***Note: For the Hi-speed Multi-Handle ELF software using Windows 2000/XP/Vista, we would recommend that you use no more than 4 Handles. If more than 4 Handles are required, please contact us.***

# ELF Component Identification

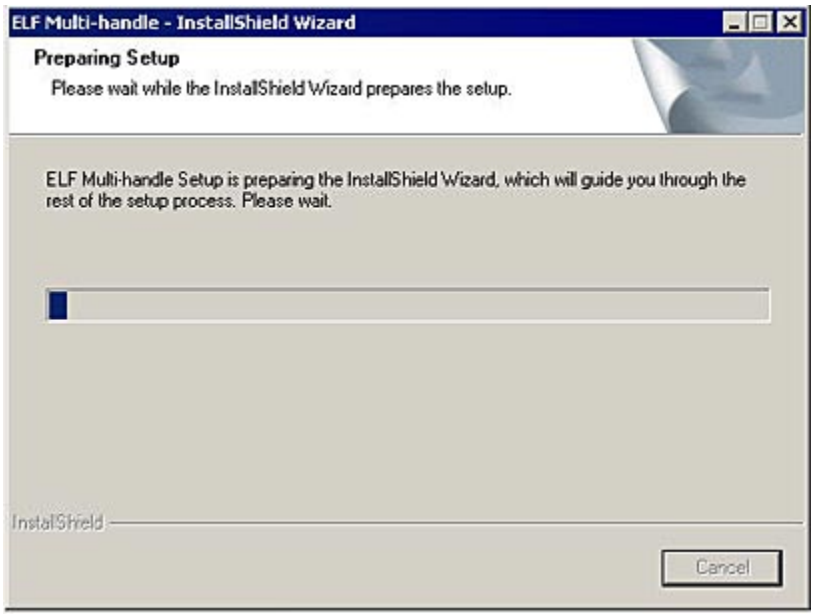
The following lists all the components that come with the ELF system. Refer to the Wireless ELF Components Identification section for components that ship with the Wireless ELF system.

<table>
<tr>
<td>(1) ELF USB Handle (single Handle systems -- multiple Handle systems vary depending on requirements). Standard length is 10 feet.<br> </td>
<td>(1) Software CD<br> </td>
</tr>
<tr>
<td colspan="2">(3) FlexiForce B201 Sensors (one in each of the three offered force ranges: Low (0-25 lb); Medium (0-150 lb) and High (0-1000 lb)).<br> <br>The force range (Low (L), Medium (M), or High (H)) is indicated by one of the 3 checkboxes near the tab end of the sensor. The 12 checkboxes near the sensing area containing one row of letters and one row of numbers are internal manufacturing batch codes, and do not indicate anything about the force range or functionality of the sensor.</td>
</tr>
<tr>
<td colspan="2">Note: You may be required to purchase a USB Hub (for multi-Handle ELF systems). Refer to the “Installation” section for a list of recommended USB Hubs.</td>
</tr>
</table>

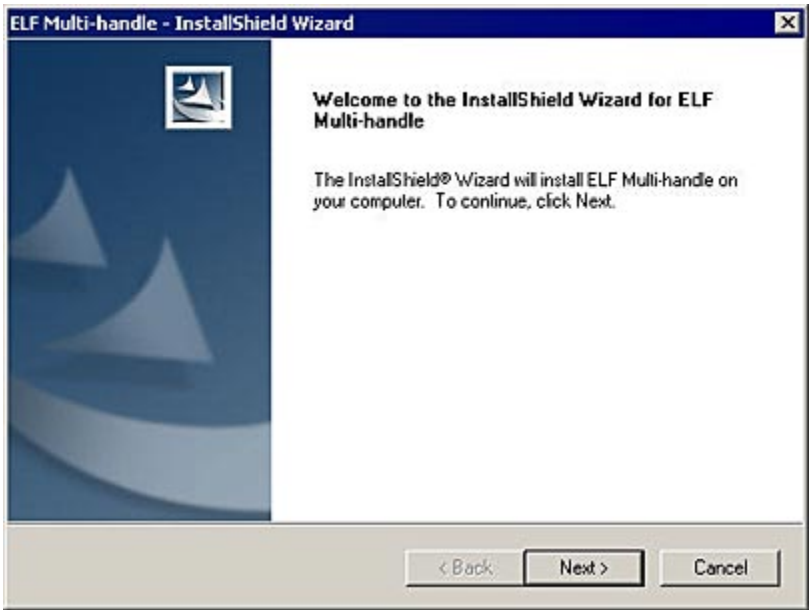
# Software Installation

Before installing the ELF software, close all other applications. To install the software, place the CD-ROM in your CD-ROM drive. If the **autorun.exe** does not start automatically, click on **Start** at the bottom left of the screen, and click on the **Run** menu item. If you put the disk in the **D:** CD-ROM Drive, type "**d:setup**" in the command line field of the *Run* dialog box, then click **OK**. The following images outline the installation process:

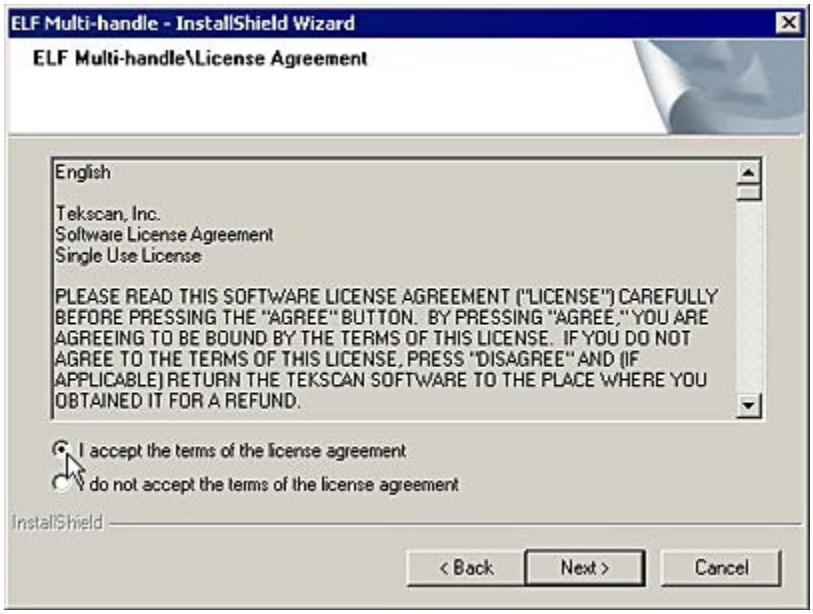
First, the InstallShield Wizard will prepare your machine for proper setup:


ELF Multi-handle - InstallShield Wizard
Preparing Setup
Please wait while the InstallShield Wizard prepares the setup.
ELF Multi-handle Setup is preparing the InstallShield Wizard, which will guide you through the rest of the setup process. Please wait.
InstallShield
Cancel

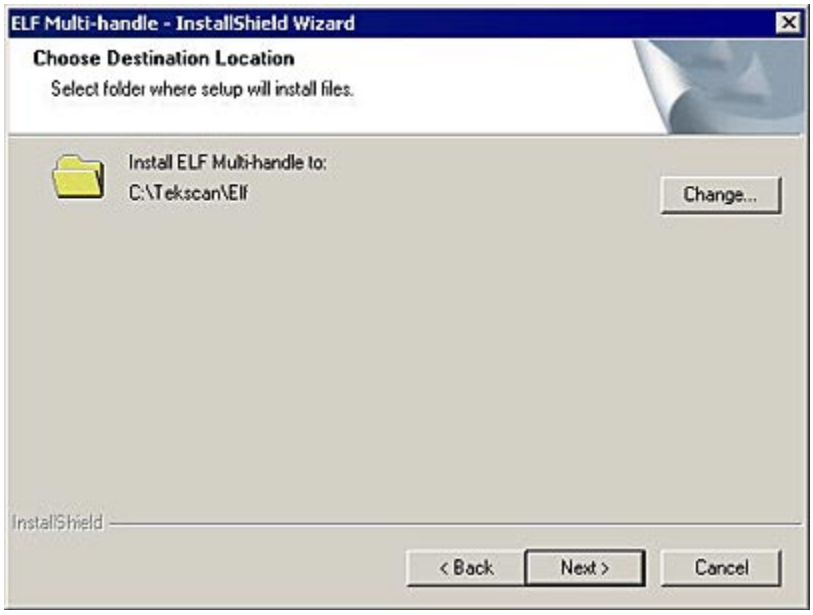
The next screen you will see is the Welcome screen. Click **Next** to continue with the Setup.


ELF Multi-handle - InstallShield Wizard
Welcome to the InstallShield Wizard for ELF Multi-handle
The InstallShield® Wizard will install ELF Multi-handle on your computer. To continue, click Next.
< Back
Next >
Cancel

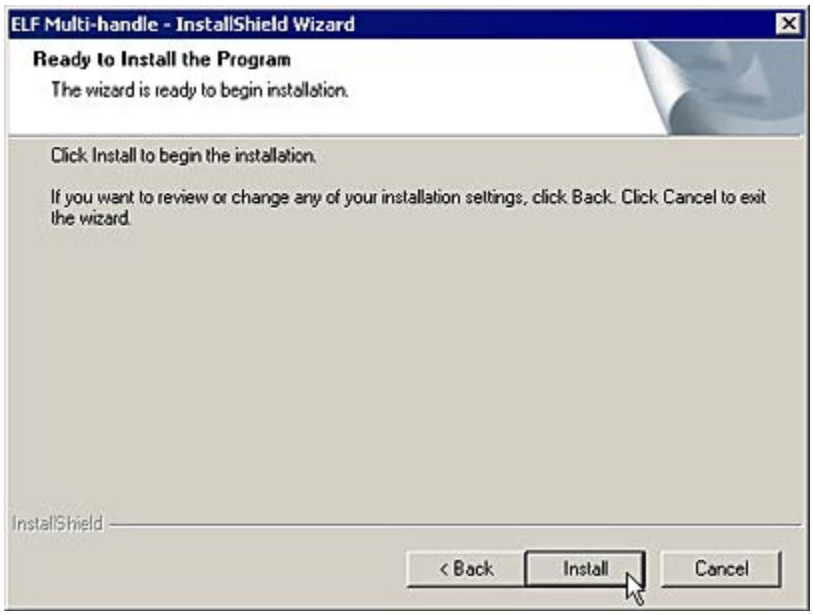
You will be taken to the License Agreement page. When you have read the License and agree to the terms, click the **Next** button to continue with your installation.


ELF Multi-handle - InstallShield Wizard
ELF Multi-handle\License Agreement
English
Tekscan, Inc.
Software License Agreement
Single Use License
PLEASE READ THIS SOFTWARE LICENSE AGREEMENT ("LICENSE") CAREFULLY BEFORE PRESSING THE "AGREE" BUTTON. BY PRESSING "AGREE," YOU ARE AGREEING TO BE BOUND BY THE TERMS OF THIS LICENSE. IF YOU DO NOT AGREE TO THE TERMS OF THIS LICENSE, PRESS "DISAGREE" AND (IF APPLICABLE) RETURN THE TEKSCAN SOFTWARE TO THE PLACE WHERE YOU OBTAINED IT FOR A REFUND.
I accept the terms of the license agreement
I do not accept the terms of the license agreement
InstallShield
< Back
Next >
Cancel

Next, the installation program will copy the necessary files to your computer. The default location is **C:\Tekscan\Elf**, however, you can change this location by clicking the **Change** button and designating a destination of your choice on your computer's hard drive.

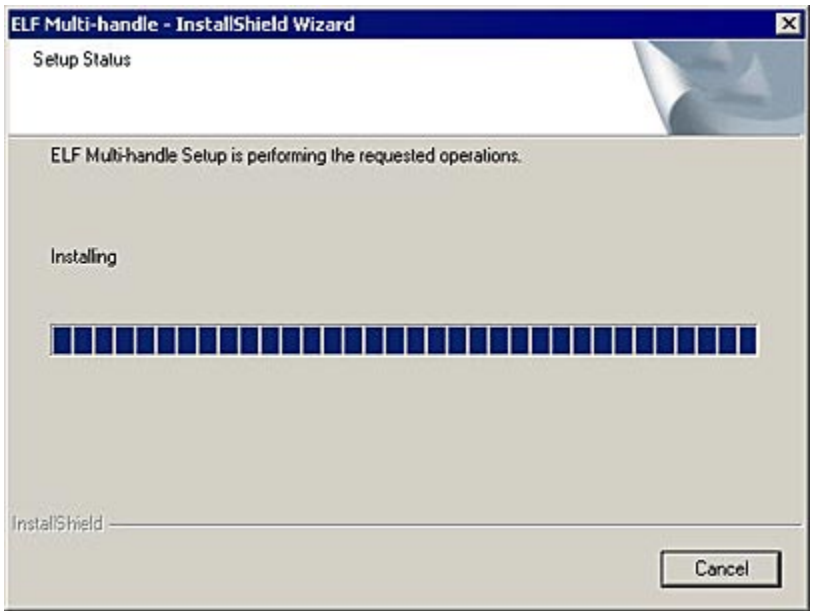


At this point, your computer has the necessary information to proceed with the installation of your ELF program. Click the **Install** button to begin installing the program on your computer.

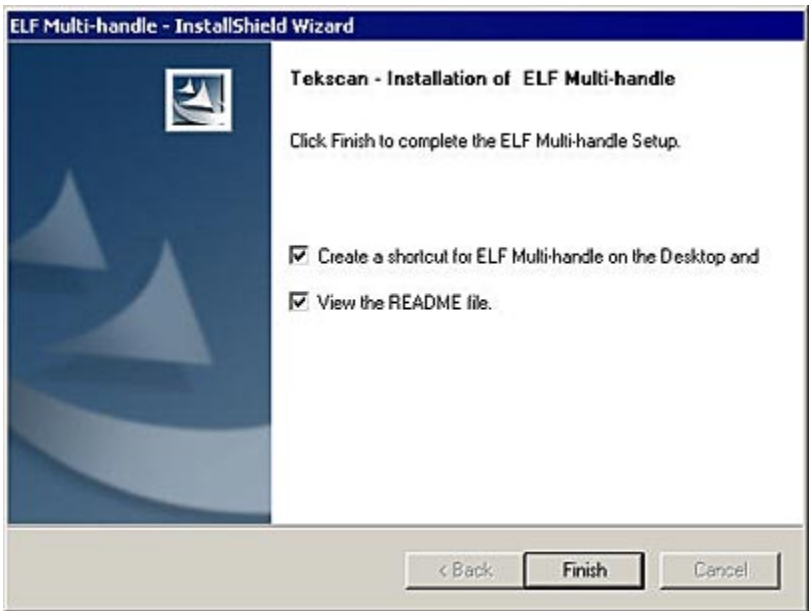

ELF Multi-handle - InstallShield Wizard
Ready to Install the Program
The wizard is ready to begin installation.
Click Install to begin the installation.
If you want to review or change any of your installation settings, click Back. Click Cancel to exit the wizard.
InstallShield
< Back
Install
Cancel

A progress bar will indicate the program is being successfully installed.

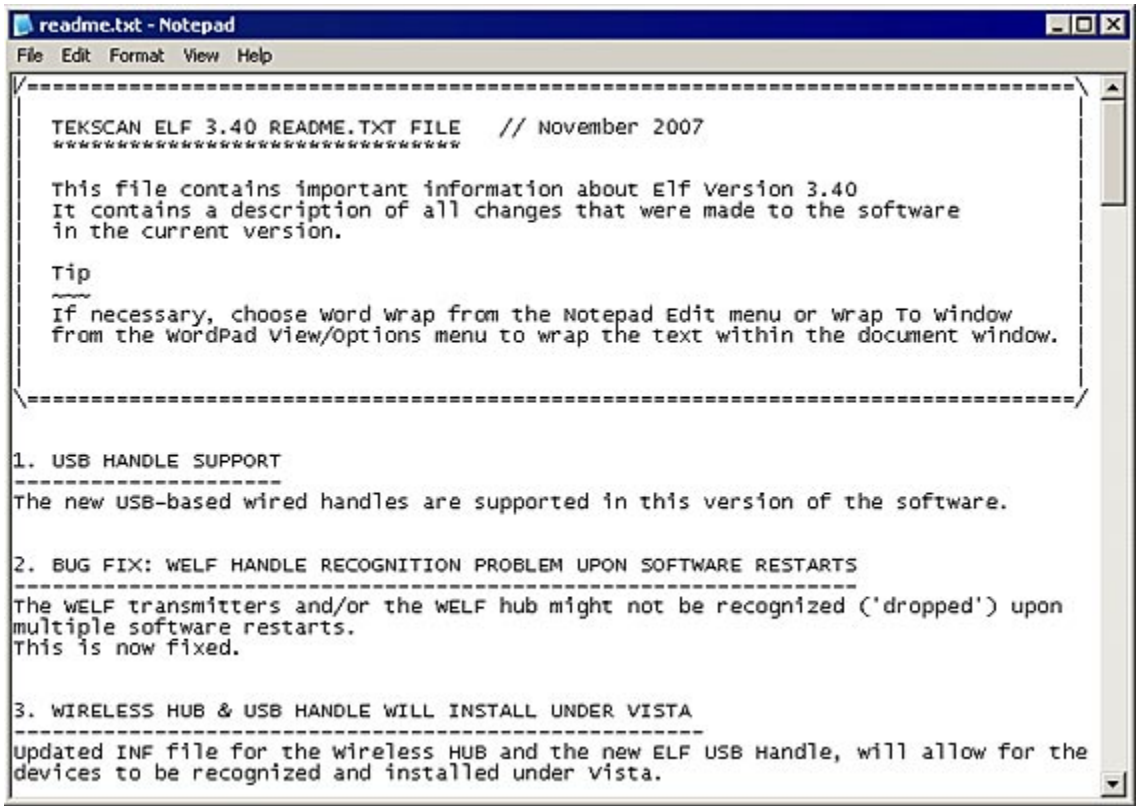
***Note: If, at any time prior to this screen you wish to stop the installation process, you can click the Cancel button.***



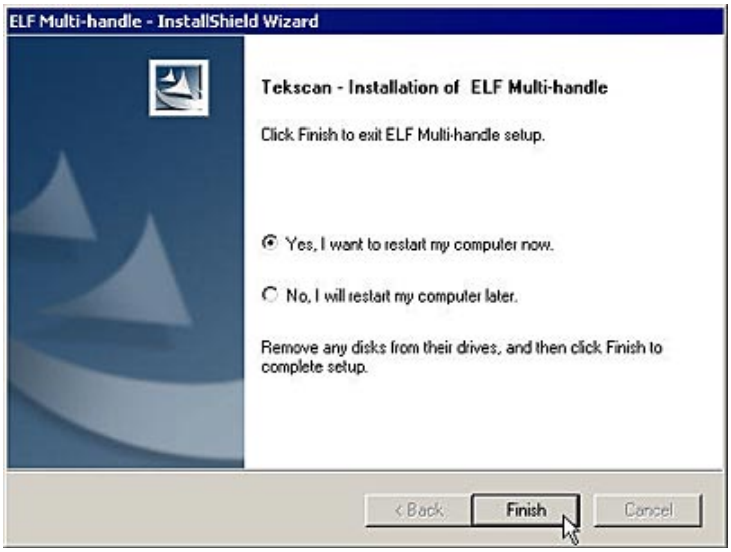
The next screen that will appear offers you the options to place a shortcut icon on your desktop and view the **README** file.


ELF Multi-handle - InstallShield Wizard
Tekscan - Installation of ELF Multi-handle
Click Finish to complete the ELF Multi-handle Setup.
Create a shortcut for ELF Multi-handle on the Desktop and
View the README file.
< Back
Finish
Cancel

If you elect to view the **README** file, it will open in a MS Notepad window, where you can read about new and updated information regarding the latest release of the ELF software.


readme.txt - Notepad
File Edit Format View Help
TEKSCAN ELF 3.40 README.TXT FILE // November 2007
This file contains important information about Elf Version 3.40
It contains a description of all changes that were made to the software
in the current version.
Tip
If necessary, choose Word Wrap from the Notepad Edit menu or Wrap To Window
from the WordPad View/Options menu to wrap the text within the document window.
1. USB HANDLE SUPPORT
The new USB-based wired handles are supported in this version of the software.
2. BUG FIX: WELF HANDLE RECOGNITION PROBLEM UPON SOFTWARE RESTARTS
The WELF transmitters and/or the WELF hub might not be recognized ('dropped') upon
multiple software restarts.
This is now fixed.
3. WIRELESS HUB & USB HANDLE WILL INSTALL UNDER VISTA
Updated INF file for the Wireless HUB and the new ELF USB Handle, will allow for the
devices to be recognized and installed under Vista.

When the installation is completed, you will need to restart your system. Click the **Finish** button, and your system will be automatically rebooted. You cannot start the ELF software without first restarting.


ELF Multi-handle - InstallShield Wizard
Tekscan - Installation of ELF Multi-handle
Click Finish to exit ELF Multi-handle setup.
Yes, I want to restart my computer now.
No, I will restart my computer later.
Remove any disks from their drives, and then click Finish to complete setup.
< Back
Finish
Cancel

The ELF splash screen will be shown (below). This indicates the ELF software is successfully loaded on your machine.

ELF
Economical Load & Force system
Data Acquisition System
from Tekscan, Inc.
Tekscan, Inc. is an ISO 9001 registered company.

The installation process is now complete. When your computer is rebooted, the application can then be launched by clicking on the **Start** button at the bottom left of the screen, and selecting **Programs > Tekscan > ELF**.

You can also launch the program by double-clicking the ELF icon on your desktop (provided you opted to place an icon on your desktop during the installation procedure).

# Hardware Installation

The ELF system hardware includes the **Sensor Handle(s)**, ELF software, and the **FlexiForce sensor(s)**. If you are using the Multi-Handle ELF system, refer to the instructions included. Connect one ELF handle to each USB port you wish to use during testing.

***The image below displays the USB connection for the ELF system:***

***Multi-Handle system with handles connected to the USB hub***

1. Connect the Handle's USB connector to an available USB port on the PC or laptop. Or, in a multi-handle configuration, you may choose to use a USB hub to connect your Handles. Connect the Hub to the USB port of the PC or laptop. Then connect each USB handle to the USB ports on the Hub.

2. Insert the sensor into the Handle. To do this, ensure that the "UP" printed on the sensor is correctly oriented (on the same side as the blue button on the handle), and then press down the blue button. Slide the sensor tab into the slot until it reaches its mechanical stop, and release the blue button.

   Do not force the sensor if it will not slide into the handle easily. If the sensor will not slide in easily, check that there is nothing inside the handle blocking the sensor, and check that the end of the sensor is not bent or folded.

If the software has been installed, and is running, when the sensor is correctly inserted, an audible beep will be heard, and the "Sensor OK" icon on the Toolbar will be a green square; otherwise it will be "grayed out".

***Note: Follow Static control procedures when handling the sensor while it is in use.***

# USB ELF System Specifications

The following table outlines the specifications for the USB ELF system:

| | |
|---|---|
| **COMMUNICATION/DATA ACQUISITION** | |
| COMMUNICATION PROTOCOL TO HOST COMPUTER | USB 2.0 |
| SCAN SPEED | Up to 960 Hz. |
| DIGITAL PRESSURE RESOLUTION | 8 BIT |
| **ELECTRICAL** | |
| POWER SOURCE: | USB Powered |
| POWER CONSUMPTION: | 25mA MAX at 5V |
| **MECHANICAL** | |
| **USB CABLE (non-detachable)** | |
| LENGTH ft (mm) | 10 (3048) - Standard |
| **ELF ENCLOSURE** | |
| SIZE LxWxH in (mm) | 2.75 x 1.25 x 0.5in (69.85 x 31.75 x 12.7mm) |
| WEIGHT lbs (kgs) (w/cable) | 3.2 Oz (90g) |
| **AMBIENT OPERATING CONDITIONS** | |
| TEMPERATURE: $^{o}$F ($^{o}$C) | 14 to 131 (-10 to 55) Prolonged use at high Temperatures should be avoided |
| HUMIDITY: % | 0 to 90 (non condensing) |
| PRESSURE: psi (kPa) | 1.7 to 14.7 (11.6 to 101.3) (sea level to 50,000 ft) |
| **STORAGE AND TRANSPORT CONDITIONS** | |
| TEMPERATURE: $^{o}$F ($^{o}$C) | -4 to 131 (-20 to 55) Short-Term<br>41 to 104 (5 to 40) Long-Term |
| HUMIDITY: % | 0 to 90 (non condensing) |
| PRESSURE: psi (kPa) | 1.7 to 14.7 (11.6 to 101.3) (sea level to 50,000 ft) |

# OVERVIEW

This section outlines the Various Hardware and Software components that ship with your system.

## Sensors

The FlexiForce sensor is an ultra-thin and flexible printed circuit. Sensors are available in three full-scale force ranges: ***Low*** (25 lbf ), ***Medium*** (150 lbf ), and ***High*** (1000 lbf ). The "active sensing area" is a 0.375” diameter circle at the end of the sensor. The sensors are constructed of two layers of substrate, such as a polyester film. On each layer, a conductive material (silver) is applied, followed by a layer of pressure-sensitive ink. Adhesive is then used to laminate the two layers of substrate together to form the sensor. The "active sensing area" is defined by the silver circle on top of the pressure sensitive ink. Silver extends from the sensing area to the connectors at the other end of the sensor, forming the conductive leads.

The sensor acts as a variable resistor in an electrical circuit. When the sensor is unloaded, its resistance is very high (greater than 5 Meg-ohm); when a force is applied to the sensor, the resistance decreases. This resistance is read, and an 8-bit analog-to-digital converter changes the output to a digital value in the range of 0 to 255.

There are two types of FlexiForce sensors available, as outlined in the chart below:

| ***Sensor*** | ***System*** | ***Specifications*** |
|---|---|---|
| A-201 | For use with your own electronics | Force ranges: A201-1 (0-1 lb), A201-25 (0-25 lbs) and A201-100 (0-1000 lbs) |
| B-201 | ELF, Multi-Handle ELF, or High-Speed ELF | Force ranges: Low (0-25 lb), Medium (0-150 lb) and High (0-1000 lb) |

## Sensor Handle

The sensor’s tab is placed into the sensor handle. The handle gathers data from the sensor, processes it, and sends it to your computer through a USB connection.

***Note: Our previous systems shipped with Serial handles. It is not recommended to use both the Serial ELF and USB ELF handles simultaneously.***

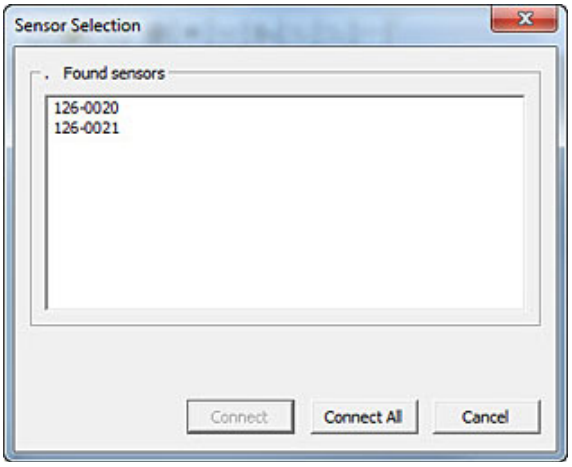
## Screen Display

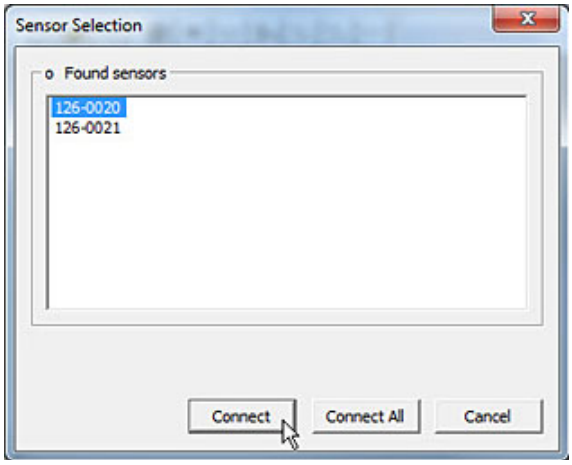
This section is a comprehensive look at the ELF screen display. Each component of the display, as well as each Main Menu option, will be described in detail.

***Note: Familiarity with MS Windows is assumed, so menu items that have the same function in standard Windows applications are not described in this manual.***

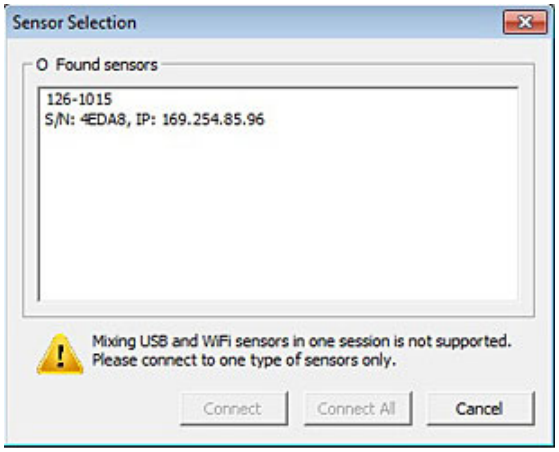
## Sensor Selection

When you initiate the Multi-Handle ELF software program, the “Sensor Selection” window is displayed on your computer screen (shown below left). Select the sensors you would like to have connected to the current Real-Time Window (using **Ctrl+Click** to select multiple sensors), and click the **Connect** button (shown below right). If you wish to connect to all sensors, you do not have to first select any sensors. Simply click the **Connect All** button.




You cannot mix between USB and Wireless (WiFi) sensors. If you select a mix of sensors, the **Connect** and **Connect All** buttons are disabled, and a warning alerting you to the issue is presented at the bottom of the dialog (shown below).




***Note: If you only have a single sensor connected (or if you are using the Single-Handle ELF system), you will not see this selection window.***

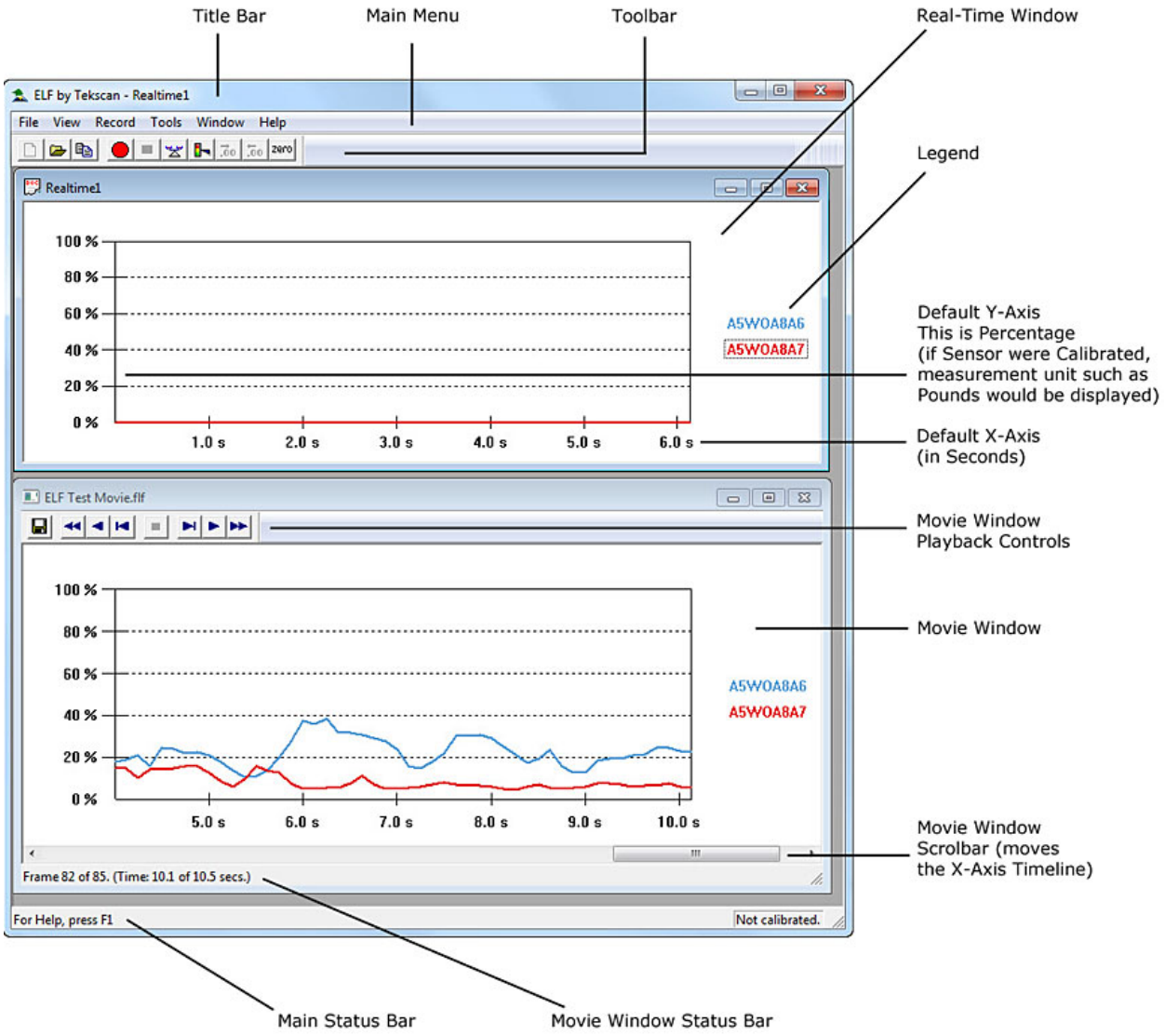
***Note: When multiple handles are recognized by the system, each time you press the “New Real-Time Window” icon on the Toolbar or select “File > New” from the menu, this window opens, allowing you to select which sensors you want displayed in the current Real-Time Window.***

***Note: You cannot connect the same sensor to multiple Real-Time Windows. However, you can clone the Real-Time Window using Window > Clone View, which will display the same sensor readout in two separate windows.***

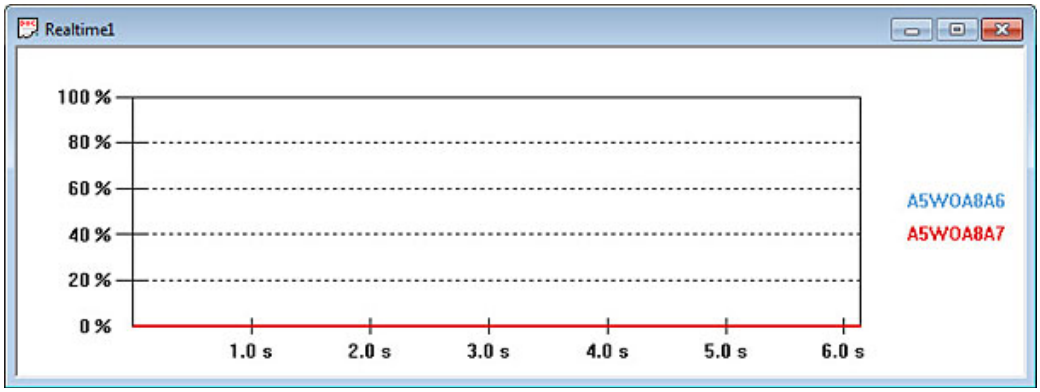
## Main Window

The Main Window consists of the **Menu Bar**, **Tool Bar**, and **Main Status Bar**, and may contain one or more **Real-time** or **Movie Windows**. The window that is selected is considered the active window. Only one window can be active at one time, and the title bars of the other windows will be grayed out. The Main Window, and its components, are shown in the figure below.

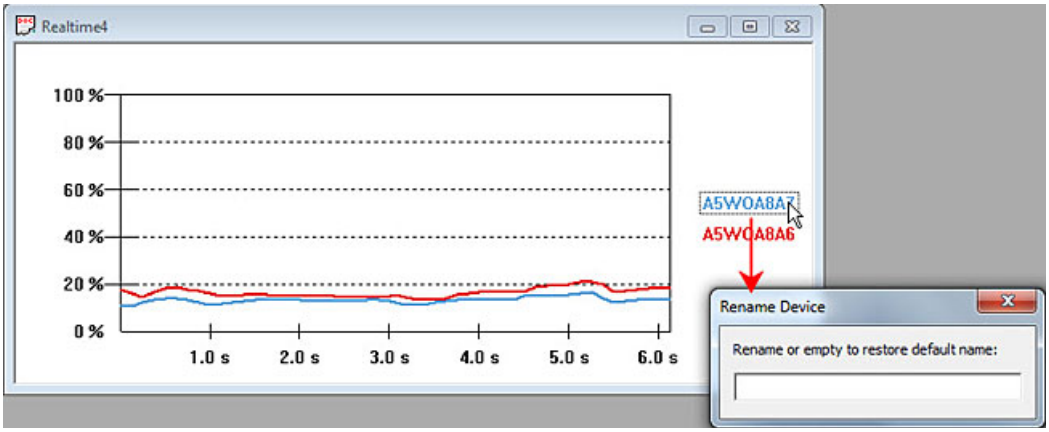
***NOTE that the figure below shows a Multi-Handle ELF system with two handles recording data.***



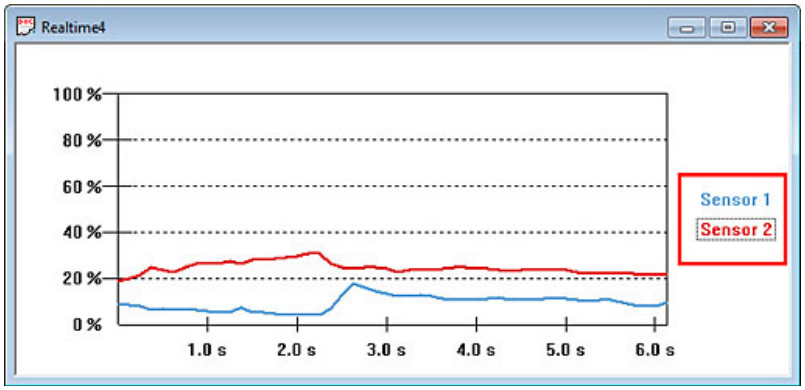
**Real-Time Window:** displays the load applied to the sensor as it is happening (in real-time). The *Properties* of this display can be changed in the **File** pull-down menu, or by clicking the right mouse button.



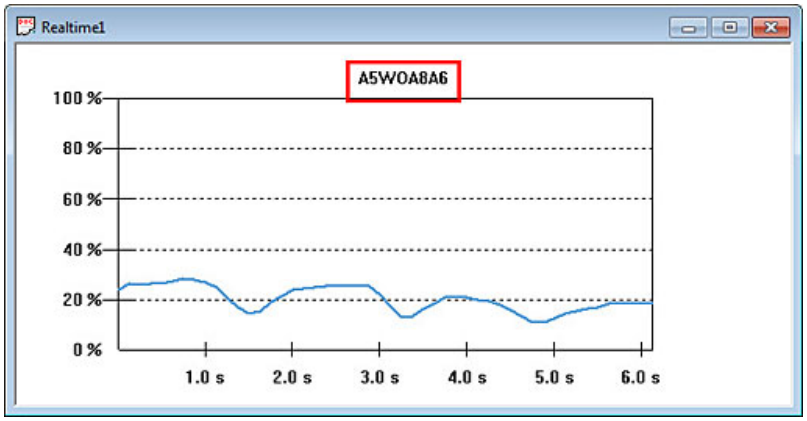

You can also change the name of the Sensor by double-clicking directly on the Sensor identification string (shown below). Then enter a new name in the "Rename Device" dialog, and press the **Enter** key on your keyboard.




In the example below, the two sensors were renamed to Sensor 1 and Sensor 2, respectively. Note that if you want to go back to using the identification number, double-click on the Sensor label once again, delete the name from the "Rename Device" dialog, and press the **Enter** key on your Keyboard.



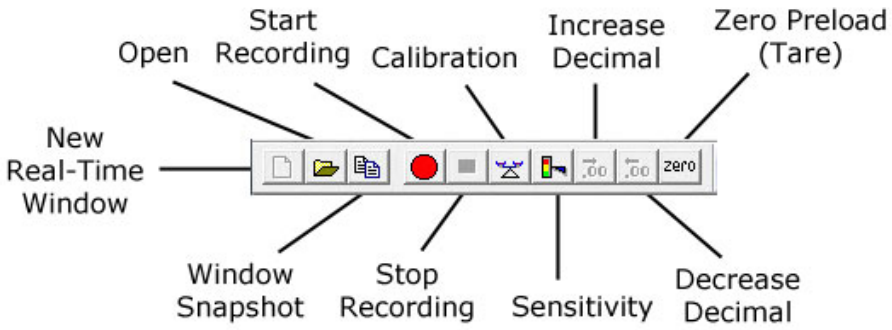
Note that if there is only a single sensor connected, the label is displayed above the graph (shown below).




**Menu Bar:** provides drop-down menus used to control the program. It is located at the top of the Main Window.

***Note: for more information, see the Main Menu section.***

**Toolbar:** provides some of the same options as the Menu Bar, but with icons replacing drop-down menus. It is located directly below the Menu Bar, at the top of the Main Window. Note that not all items in the Menu Bar have a corresponding icon on the Toolbar.



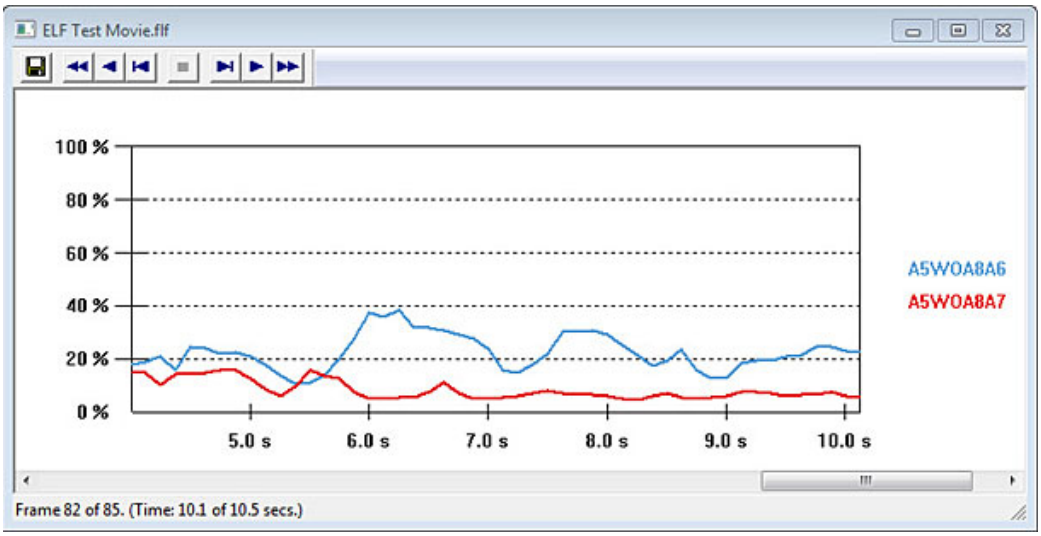

***Note: If you have the WELF system, there will be an additional "Connect to Wireless Sensor" icon at the far right side of the Toolbar. Refer to the Wireless ELF System section for further information.***

Two icons on the Toolbar do not have corresponding pull-down menus. They are the **Increase Decimal** and **Decrease Decimal** buttons. When sensors have been calibrated, units of force will be shown. Clicking these buttons will either increase or decrease the number of decimal places displayed by the software.

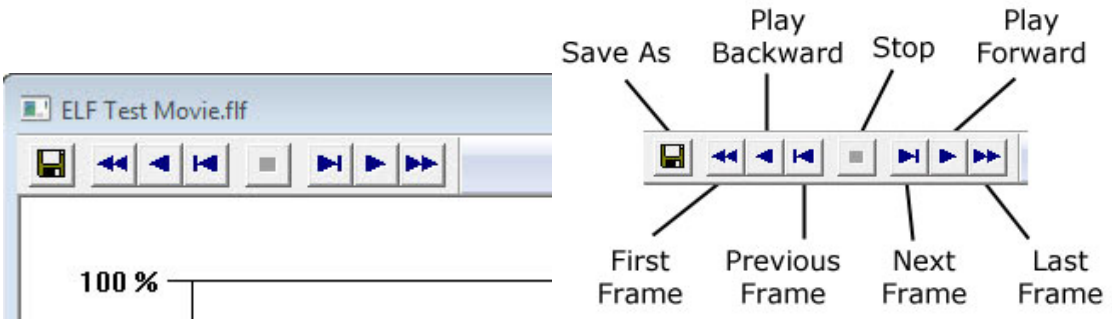
**Main Status Bar**: will either say "For Help, Press F1," or will give a description of whichever Toolbar icon is under the cursor. The Main Status Bar is located at the bottom of the Main Window.

## Movie Window

The **Movie Window** displays a previously recorded movie. It consists of the display area, a scroll bar, the **Movie Toolbar** with playback controls, and the **Movie Window Status Bar**.




**Movie Tool Bar:** This bar is located at the top of the **Movie Window**, and consists of the movie playback icons and the **Save As** icon.



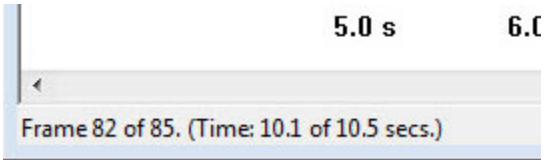

- The **Save As** icon allows you to save the current movie file under a different filename.

The **Playback** icons control the movie playback functions. They are (from left to right in the Movie Toolbar):

- **First Frame:** Positions the recording at the beginning (first frame).
- **Play Backward:** Plays the recording in reverse.
- **Previous Frame:** Plays the recording in reverse one frame each time it is clicked.
- **Stop:** Stops playback.
- **Next Frame**: Plays the recording forward one frame each time it is clicked.

- **Play Forward:** Plays the recording forward.
- **Last Frame:** Positions the recording at the end (last frame)

**Movie Window Status Bar** is located at the bottom of the Movie Window, and displays the "Frame count" (the current frame number vs. the total number in the movie). Directly above this status bar is a "scroll bar", which can be used to move to any point (frame) in the movie.

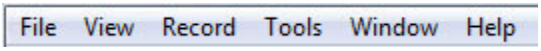



# The Main Menu

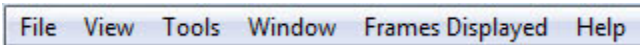
The **Main Menu** contains important commands you use to perform functions within the software. Some menu commands can be found directly in the toolbar, however, not all commands found under the menu are located on the toolbar. For this reason, it is important to become acquainted with the commands found under each menu. This section provides a thorough description of each command and dialog box found under these menus.

It is important to note that the Main Menu changes, depending where your "focus" lies. The reason for this difference is because there are some commands that can only be accessed from a Movie Window, and others from a Real-time Window. For example, if you have two windows open, one a Real-time Window, and the other a Movie Window, the Main Menu will contain a different set of submenus and commands. The following display shows the difference between the two Main Menus:

The Main Menu as it appears when focus is on a Real-time Window:

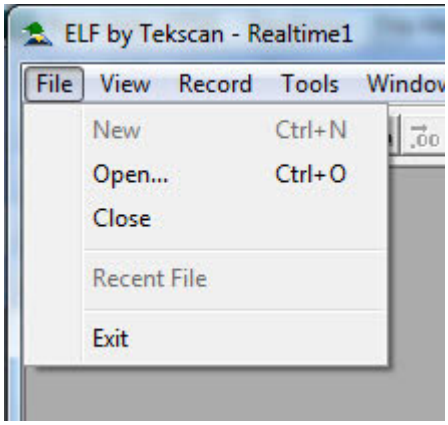



The Main Menu as it appears when focus is on a Movie Window:

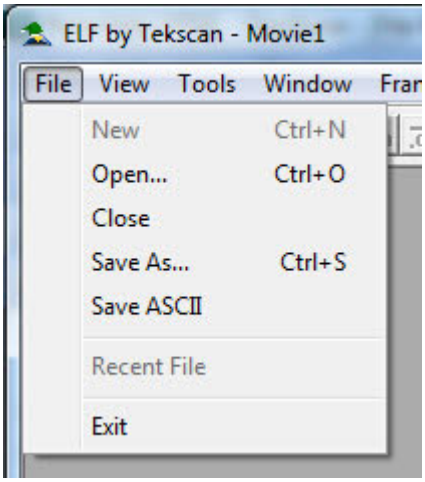


## File Menu

File Menu when focus is on a Real-time Window:

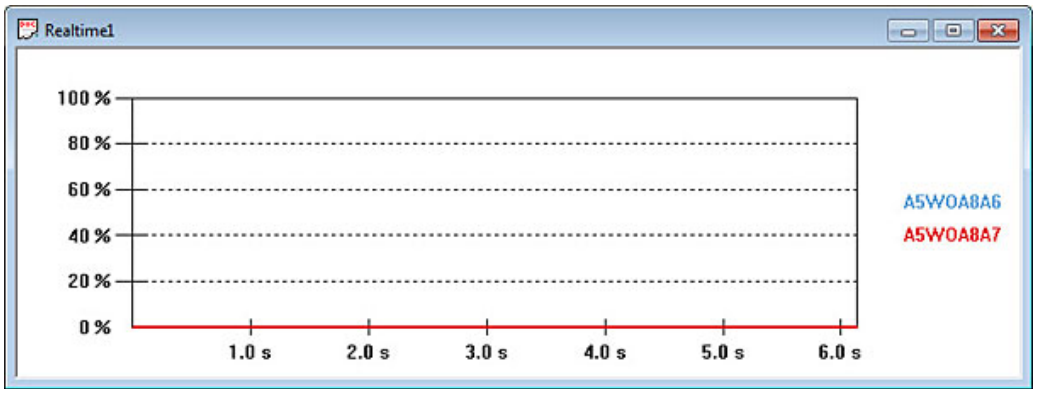



File Menu when focus is on a Movie Window:

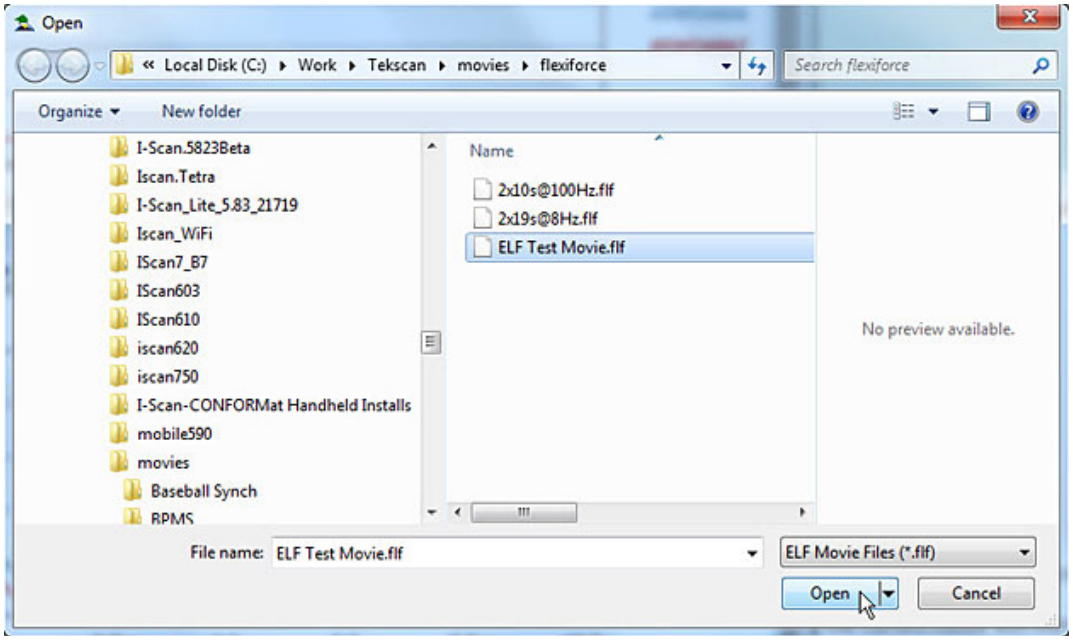



**New:** opens a new Real-time Window (shown below), in addition to any other Real-time or Movie windows that are currently open. The new Real-time Window becomes the active window when it is opened. If more than one Real-time Window is open, the force data will be displayed in all windows, in unison. If the sensor has already been calibrated, this calibration will also apply to the new Real-time Window.

***Note: When multiple handles are recognized by the system (using the Multi-Handle ELF system), each time you press the "New Real-Time Window" icon on the Toolbar or select "File > New" from the menu, the "Sensor Selection" window opens first, allowing you to select which sensors you want displayed in the current Real-Time Window. Refer to the Sensor Selection section for more information.***

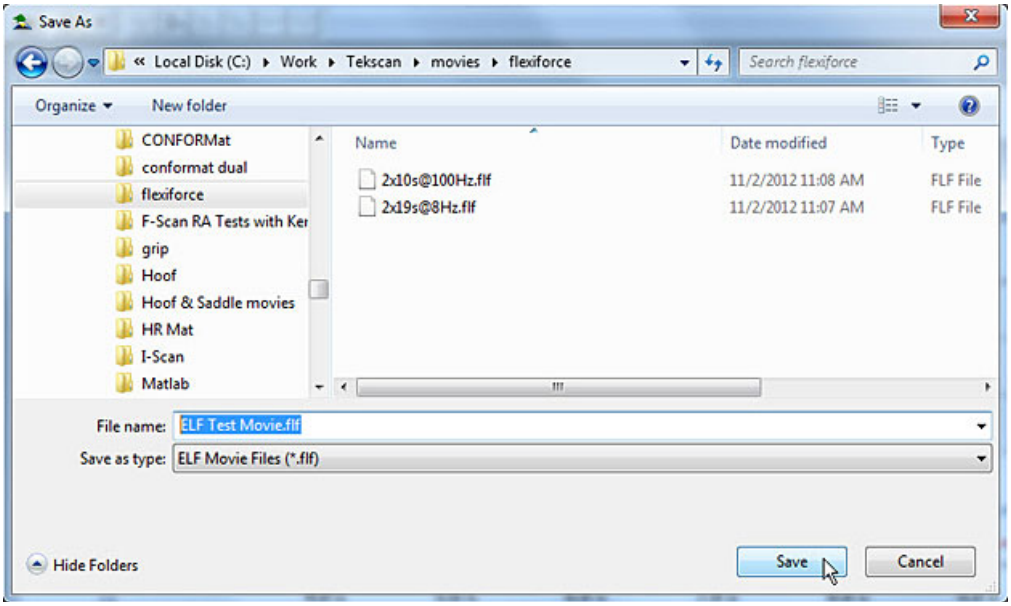


**Open:** displays the Open dialog box, which allows you to open previously recorded movie files. Only ELF movie files, with the ***.flf** file extension, can be opened.

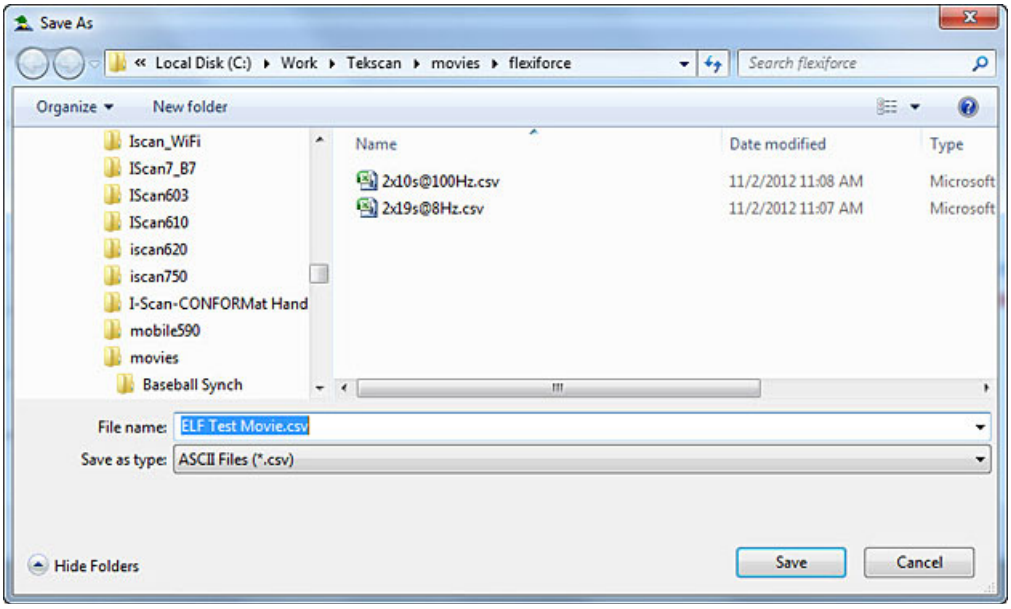



**Close:** causes the currently active Real-time or Movie Window to close. If a movie has been recorded, but not saved, the software gives the option of saving the movie file.

**Save As:** will save the current movie with the specific file name and location of your choice. ELF movie files must have the extension ***.flf**. Your system may limit filenames to eight characters. This menu item can be used to save a movie file under more than one filename.



**Save As ASCII:** saves the current Movie frame as an ASCII file, with the extension ***.csv**. Since these files are in **ASCII** (**comma separated value**) format, they can be imported into a spreadsheet program (e.g. MS Excel), or they can be opened in a text editor or word processing program (e.g. MS Word) in order to review and manipulate the data.

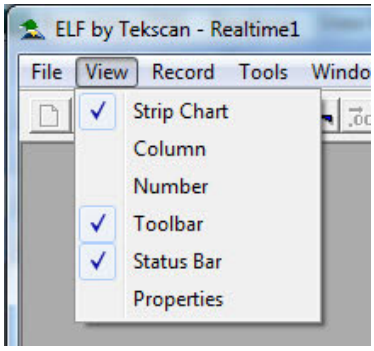



The force data is displayed as however many sensors you are measuring (1-16); the first is the elapsed time (in seconds), and the others are the applied force value (in the selected units) at that point (shown below). A data point is recorded each time the sensor data is read, so many more data points are recorded when "Fast Recording" is used (refer to the **Settings** menu item).

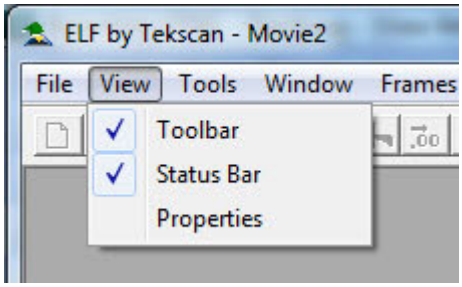
| Seconds | Sensor 1 | Sensor 2 | Sensor 3 |
|---|---|---|---|
| 0 | 7.894737 | 5.263158 | 5.263158 |
| 0.125 | 44.73684 | 15.78947 | 5.263158 |
| 0.25 | 97.36842 | 92.10526 | 15.78947 |
| 0.375 | 134.2105 | 171.0526 | 73.68421 |

## View Menu

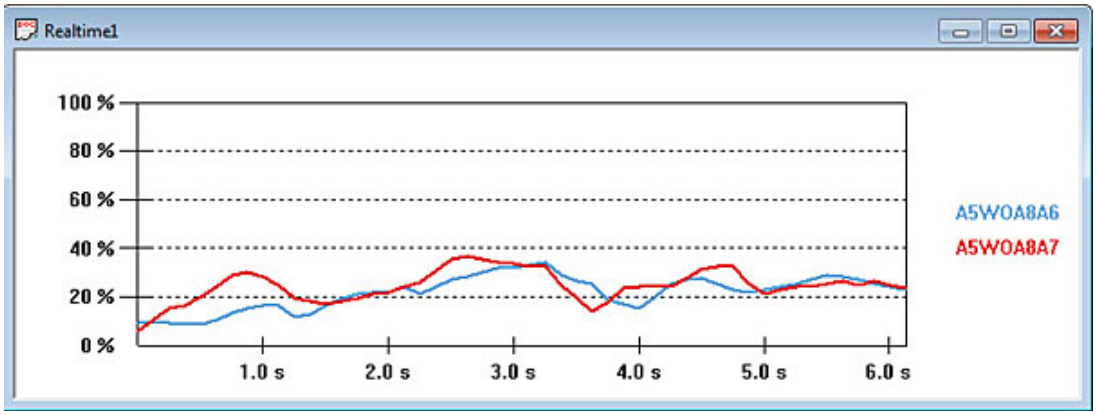
View Menu when focus is on a Real-time Window:



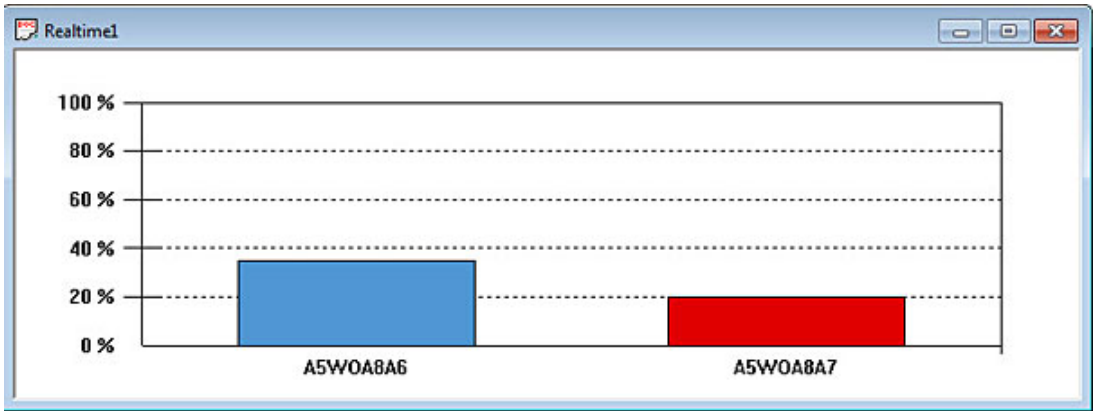

View Menu when focus is on a Movie Window:



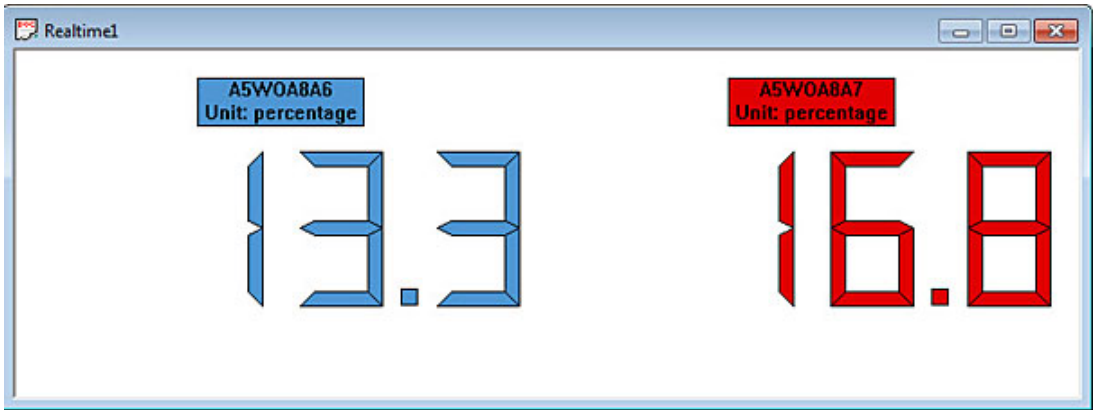
**Strip Chart:** is the default display mode, where force value is displayed on the Y-Axis and elapsed time is displayed on the X-Axis.




**Column:** displays each COM port individually, with force value displayed on the Y-Axis. Each column is color-coded to indicate the individual COM ports. As time elapses, the columns indicate changes in force.

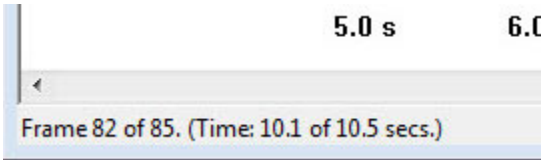



**Number:** displays each COM port as numerical values. Each numerical value is color coded to indicate the individual COM ports. As time elapses, the numbers change to indicate changes in force.

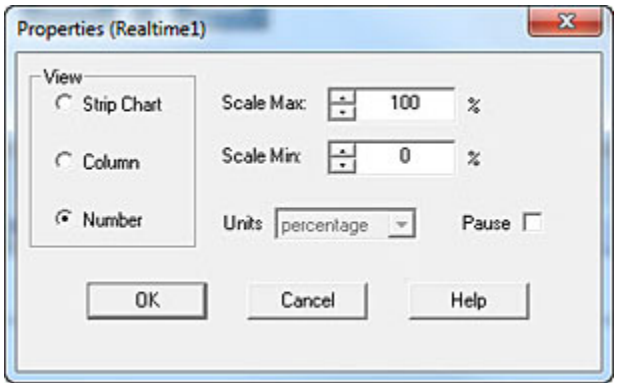


**Toolbar:** This item is used to display or hide the Movie and Main Toolbars. These toolbars can be toggled by clicking this menu item on and off. If a Real-time Window is active, this menu item affects the Main Toolbar. If a Movie window is active, this menu item affects the Movie Toolbar.

**Status Bar:** This item is used to display or hide the Movie and Main Status Bars. These status bars can be toggled by clicking this menu item on and off. If a Real-time window is active, this menu item affects the Main Status Bar. If a Movie window is active, this menu item affects the Movie Status Bar.




**Properties:** opens the *Properties* dialog box (shown following), which allows you to change how the data is displayed on the screen. Any changes made here will only affect the currently active Real-time or Movie Window. The *Properties* dialog box will also appear whenever you click the right mouse button over a Real-time or Movie Window.

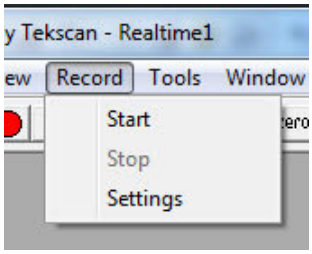


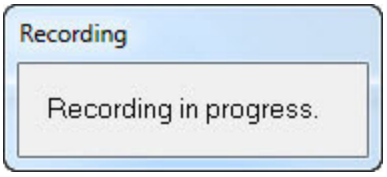

Under *View*, you can select whether to display the force data as a Strip Chart, **Column**, or **Number**. Strip Chart shows the pressure data in the form of a chart, with elapsed time (in seconds) on the X-axis, and the selected units on the Y-axis. Column displays the data as a single column, with the force values on the Y-axis. Number displays the force data as a digital readout.

In the *Properties* dialog box, you may also change the **Scale Max**, **Scale Min**, and **Units**. Under Units, the display units (Percentage, Grams, Kilograms, Newtons, and Pound) are selected. **Scale Min** and **Scale Max** set the range of values that will be displayed. Certain default maximum and minimum values will be displayed for the selected units, and these values can be changed by clicking on the up and down arrows to the right of the numbers. Selecting **Pause** causes the current Real-time window to "freeze", or to ignore all commands. When this is selected, the word "Pause" will be added to the Title Bar of the window. Movie windows cannot be paused.

## Record Menu

Record Menu (only available when focus is on a Real-time Window):

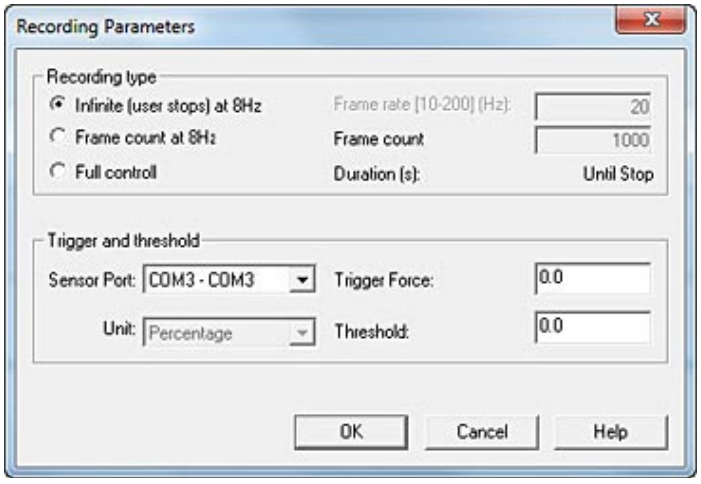



**Start:** is used to make a recording (movie). When this is selected, the software begins recording a movie of the current Real-time window data using the settings that have been selected (see the "Settings" menu item below). When data is being recorded, the *Recording* message will appear (shown at right), and the "Recording On" icon (on the Main Toolbar) will become active (the red circle will become "grayed out", and the square "Stop" button -- black color -- will become visible). If "Triggering" is in effect, and **Record** is selected, the "Waiting for Trigger" message will be displayed until the trigger force is reached. Movies created by the ELF system are stored as ***.flf** files.

**Stop:** will cause the software to stop recording the active Real-time Window, even if the correct number of movie frames (as selected in "Settings") have not yet been recorded.

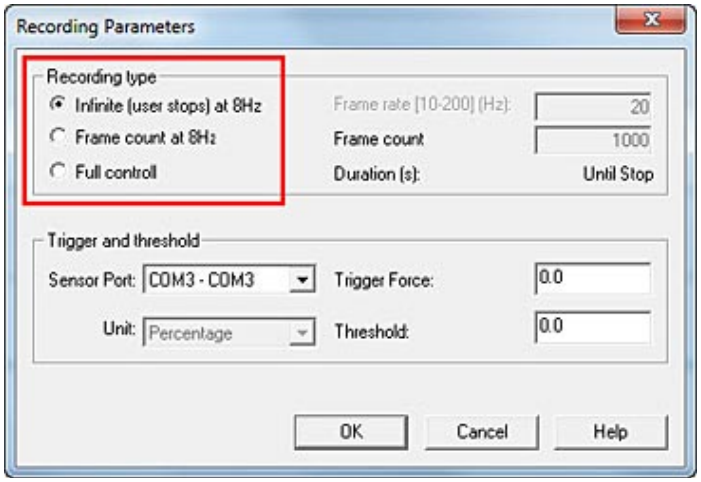
**Settings:** brings up the *Recording Parameters* dialog box, which allows you to change the current recording parameters. Under 'Recording Type,' there are three possibilities that may be selected.




***Note: The Frequency, or acquisition rate, is measured in Hertz (Hz), which is the number of times per second the sensor output is read by the software.***

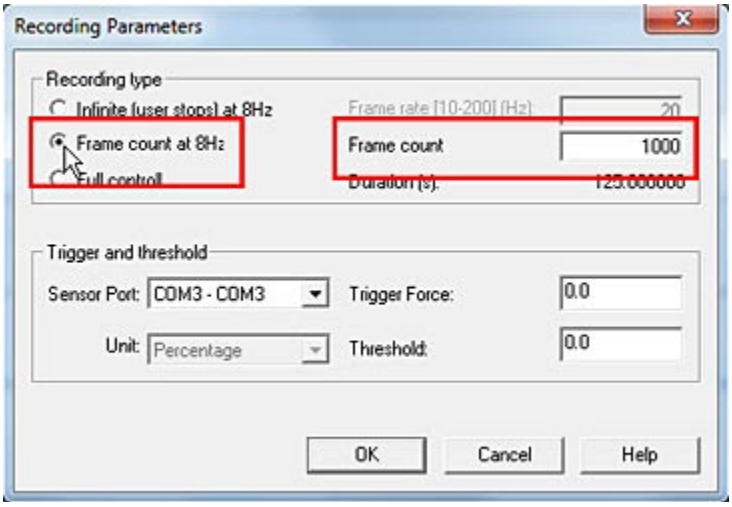
## Standard ELF Recording Parameters

If you have purchased the standard ELF system, the software will record at a lower range of speeds, and your choices for 'Recording Types' include **Infinite**, **Frame Count** and **Full Control** (below).

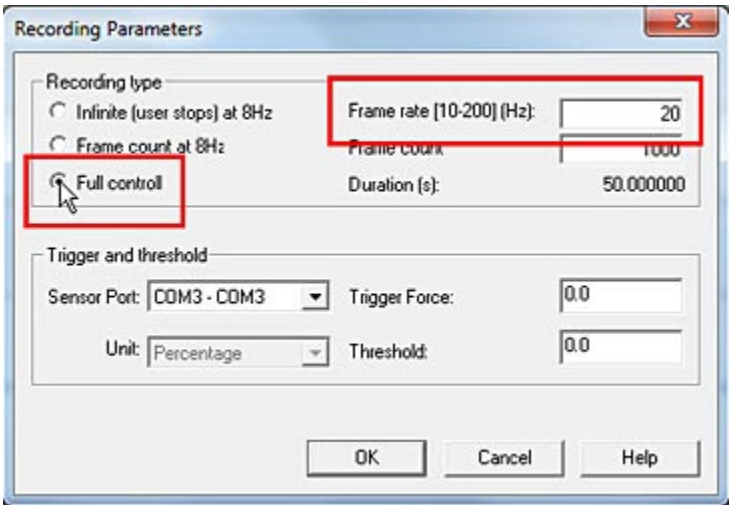



When **Infinite** is selected, recording will continue until **Stop** is selected (from the *Record* menu or by clicking its icon on the Toolbar).

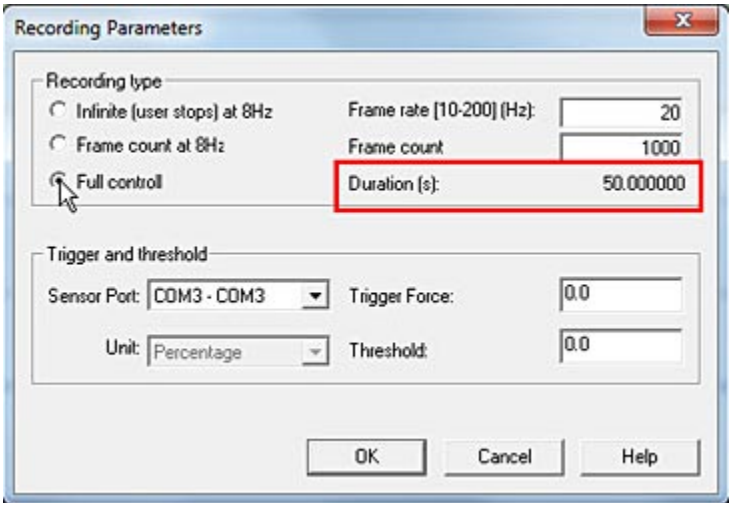
When **Frame Count** is selected, the number of "Frames to Record" may be entered in the "Frame count" field on the right side of the dialog. The recording will stop when this number of frames has been recorded, regardless of the duration of the movie.



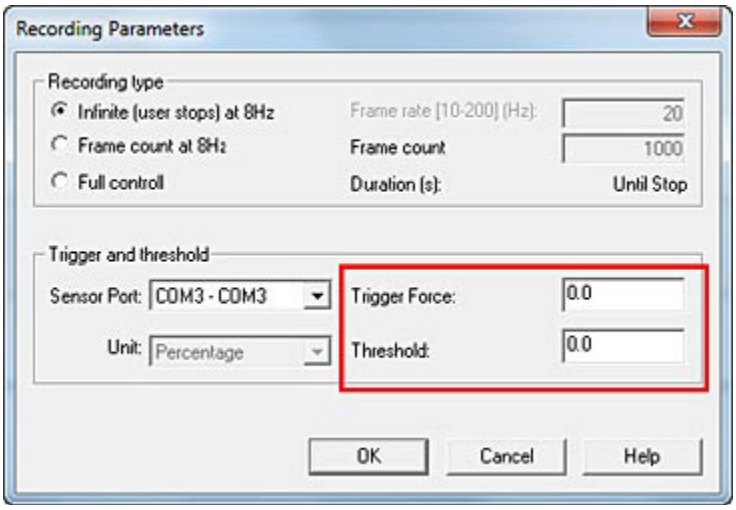
When **Full control**, is selected, the "Frames to Record" may be entered, and the *Recording Frequency (Hz)* may be selected in the “Frame rate” field to the right. In "Full control" applications, recordings can be obtained at user-defined frequencies between 10 and 200 Hz (standard system). For the High-Speed ELF system, frequencies as high as 5.7 kHz can be obtained.




The **Duration** is listed below the *Frame Count*; it will either say "Until Stop" if **Infinite** is selected, or the approximate duration (in seconds) the recording will take to complete if **Frame Count** is specified.

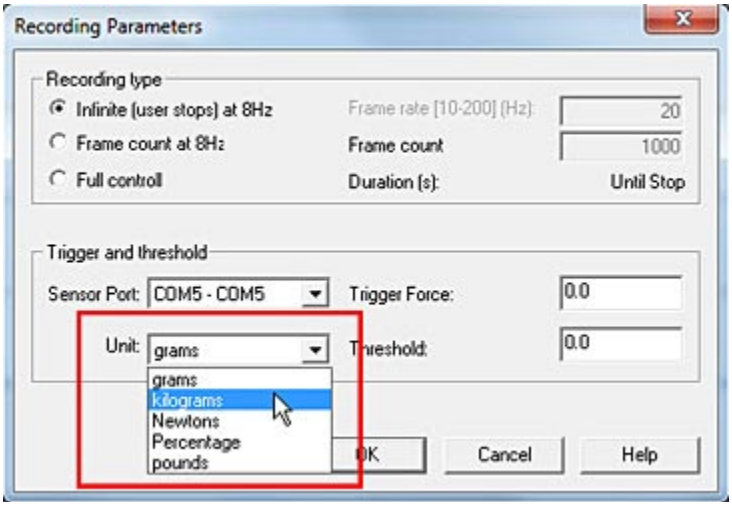


The *Recording Parameters* dialog box also allows you to "trigger" the start of a recording. If you enter a value in the **Trigger Force** field, and select the appropriate measurement units, recording will not begin until that force is exerted on the sensor. Enter a zero in this field to disable "triggering". Only one **Trigger Force** value may be entered, and will apply to all sensors being used for testing.



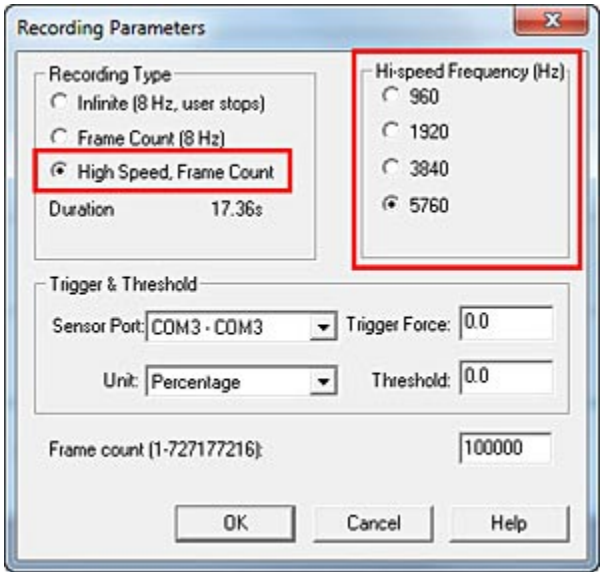

The **Threshold** may be set for each individual COM port, so that each sensor has a different threshold. This may be used in combination with the **Trigger Force** value to begin recording when force is exerted on a specific sensor.

***Note: If no calibration has been performed, the only available units will be shown as a Percentage. If a calibration has been performed, you may select from a number of force units.***



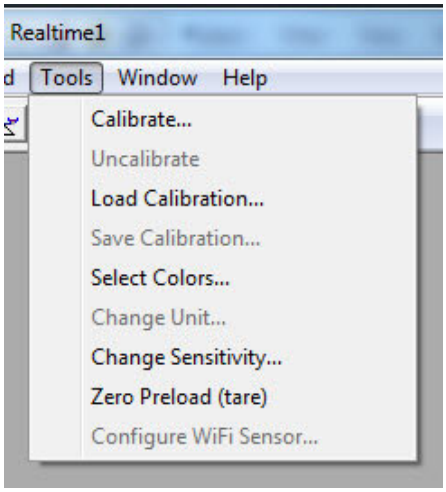
### ELF Hi-Speed Recording Parameters

If you have purchased the ELF Hi-Speed system, the software will record at a higher range of speeds (up to 5760 Hz) , and your *Recording Parameters* dialog box will look slightly different. Your choices for Recording Type include **Infinite**, **Frame Count**, and **High Speed**.

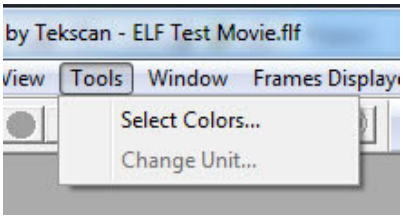



## Tools Menu

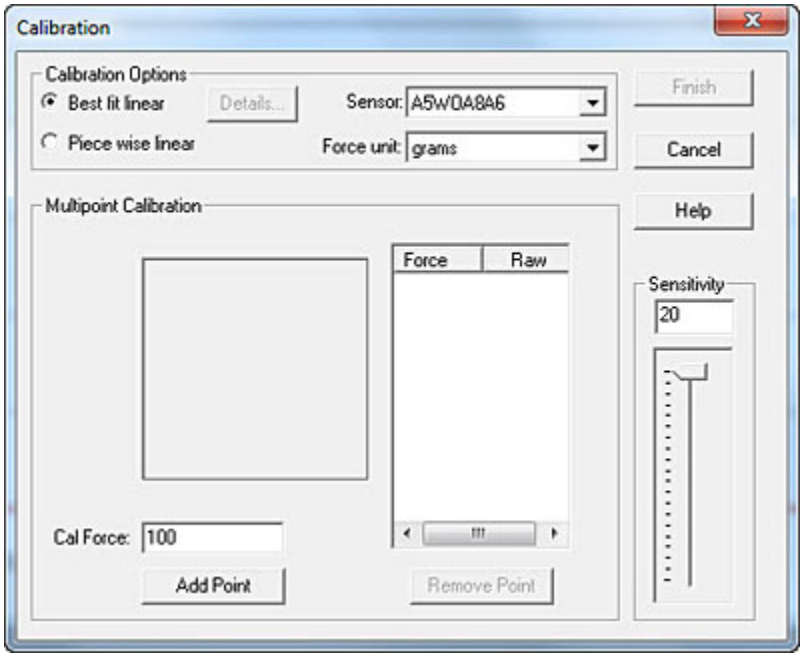
Tools Menu when focus is on a Real-time Window:



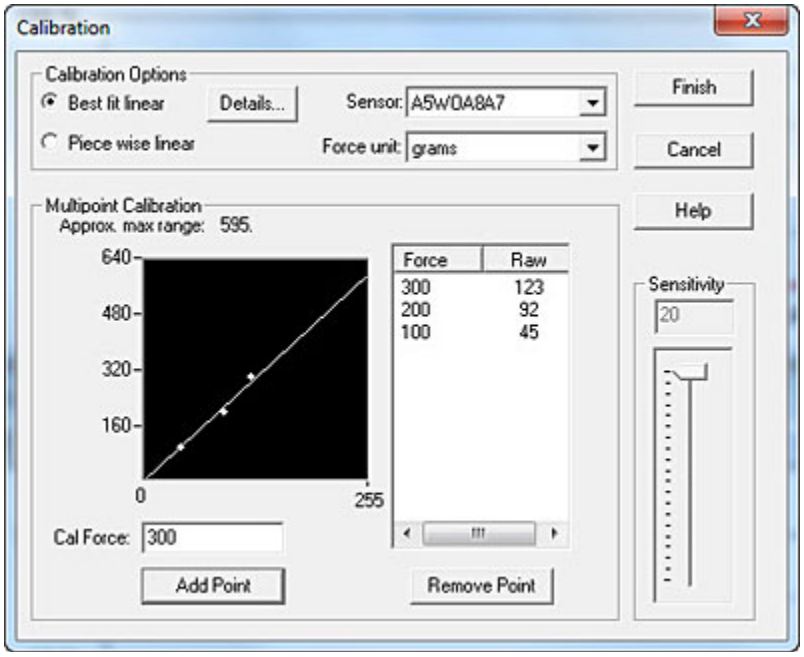

Tools Menu when focus is on a Movie Window:



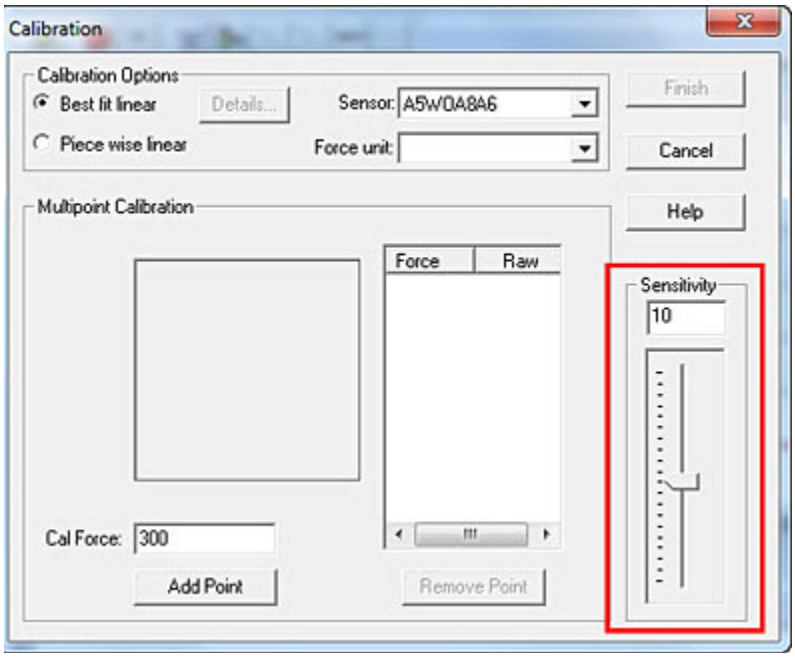
**Calibrate:** Opens the ELF *Calibration* dialog box, which enables you to calibrate the sensor and adjust the system sensitivity. Refer to the **Calibration** section for the complete calibration procedure and a thorough description of the process.




In the *Calibration* dialog box, the calibration load is entered under **Cal Force** by typing in the value, and selecting the appropriate units (Grams, Kilograms, Newtons, Pounds). Clicking the **OK** button will then begin the calibration process. The resulting calibration can be saved as a file by selecting **Save Calibration** under the same Tools menu.

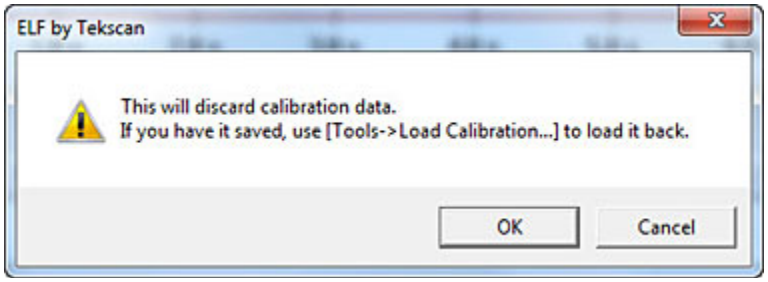


**Sensitivity** (or "Adjustable Gain") is also adjusted in the *Calibration* dialog box. The Sensitivity should be adjusted whenever necessary to keep the force display in a usable range. Sensitivity settings are saved between sessions, and are included with calibration files. The sensitivity adjustment is described in detail in the Calibration Procedure.

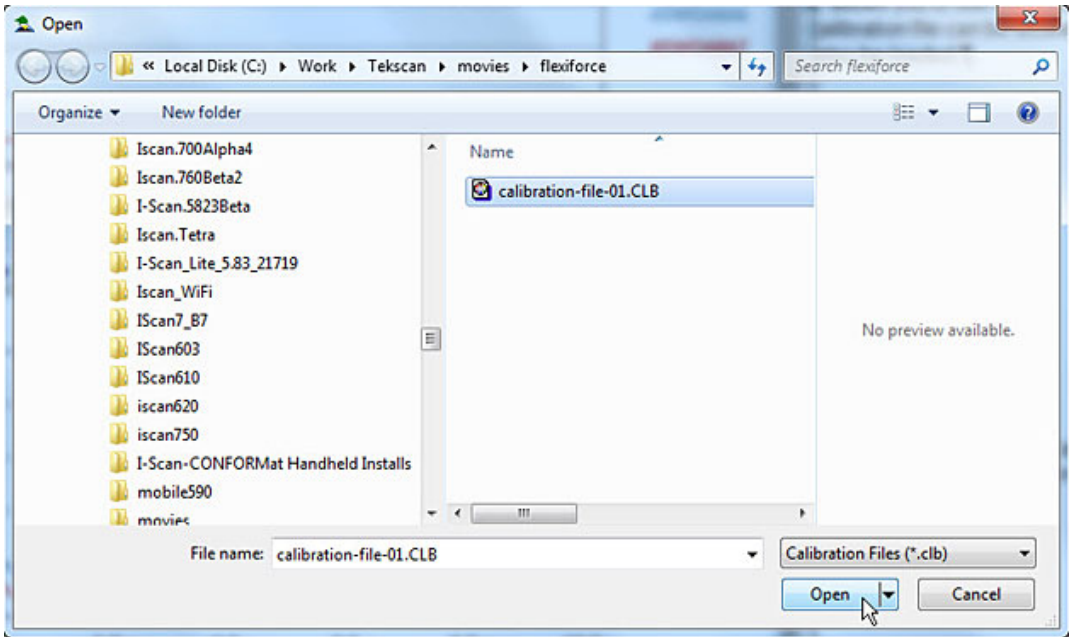



**Uncalibrate:** This option removes the sensor's calibration data. When this item is selected, a dialog box will appear, giving the option of canceling the Uncalibrate operation. Uncalibrate does not affect the Sensitivity setting.

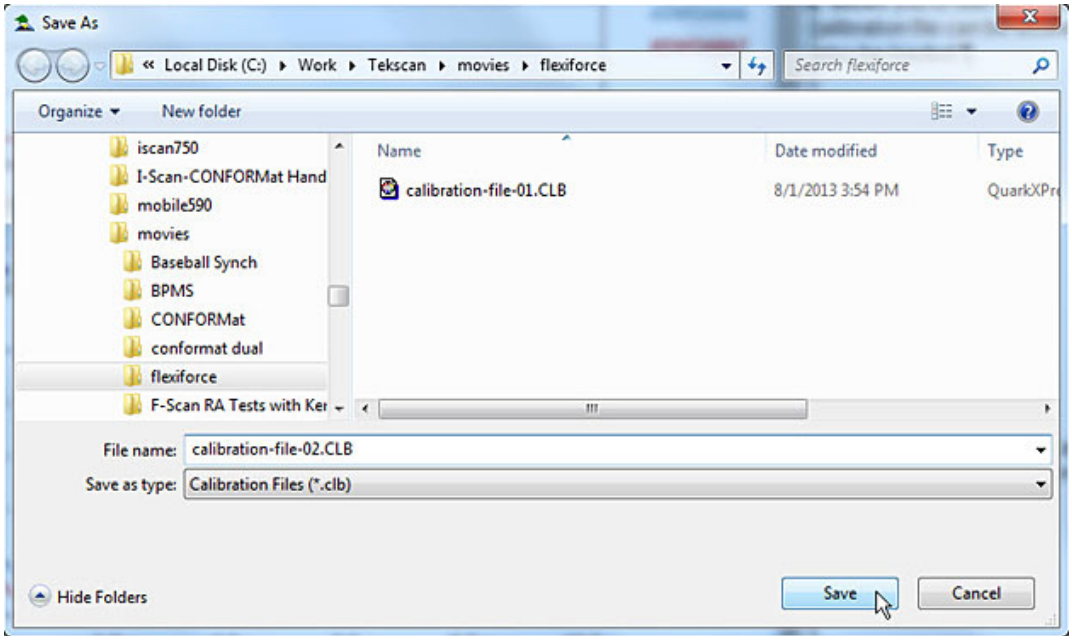
If you wish to recalibrate the sensor during the same testing session, select **Tools > Uncalibrate** to reset the calibration of the current window. The current calibration will be saved between sessions, unless **Uncalibrate** is selected. A dialog prompt will open asking if you are sure you want to uncalibrate. It is usually a good idea to save your calibration file before you uncalibrate, as there is no way to retrieve your calibration once you use this command and click **OK** in the message prompt below.


ELF by Tekscan
This will discard calibration data.
If you have it saved, use [Tools->Load Calibration...] to load it back.
OK
Cancel

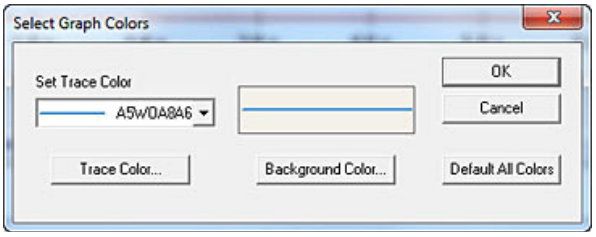
**Load Calibration:** allows you to use the calibration data from a previously-saved file for your current Real-time Window. When this item is selected, an *Open* dialog box appears, and the calibration file can be located and opened. Only ELF calibration files (extension ***.clb**) can be loaded. The Sensitivity setting that was saved with the calibration file will also be loaded.

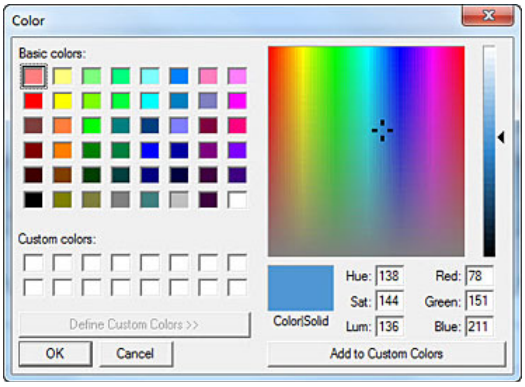



**Save Calibration:** allows you to save your current calibration as a file for future use. When this item is selected, a *Save As* dialog box appears, and the calibration file can be saved with the specific file name and location of your choice. Calibration files must have the extension ***.clb**. The Sensitivity setting is also saved with the calibration file.

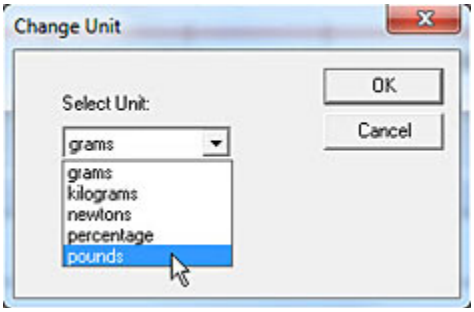


**Select Colors:** allows you to customize the background color, as well as the trace color for each ELF device in your View windows. When this item is selected, the "Select Graph Colors" dialog box appears. By clicking on either **Trace Color** or **Background Color**, an MS Windows color palette becomes available, and you can select one of the standard colors or create your own custom color for each of the COM ports (sensors). The color you choose will be used for all Movie and Real-time Windows, and will be set as the default color. To restore the original color, select the **Default All Colors** button.



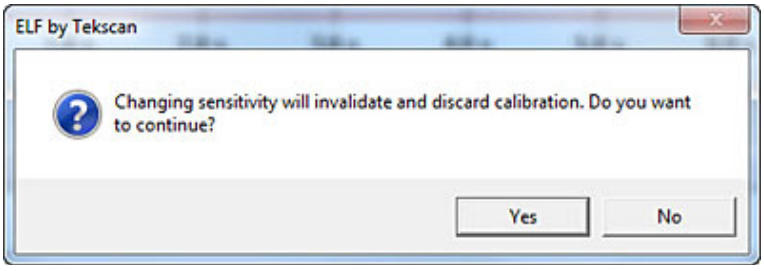




**Change Unit:** This feature allows you to quickly change the force units displayed in all windows. To use this feature, however, you must have performed a calibration. Otherwise, all force will be displayed as "raw values".

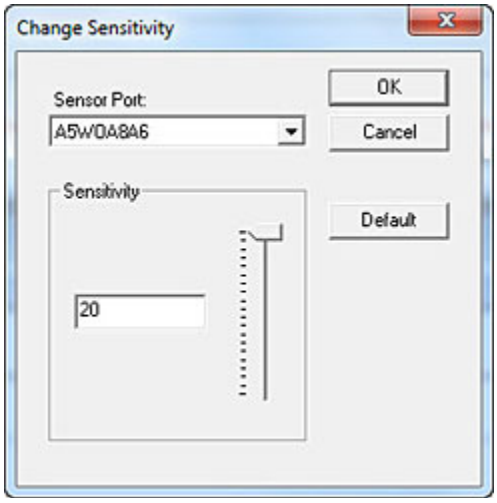



**Change Sensitivity:** This feature opens the *Change Sensitivity* Dialog box (below). You may adjust the sensitivity for each sensor/COM port. Use the drop down **Select Buttons** field to select the COM port. Then drag the slider up and down until you are satisfied. Adjust as many buttons as you like. When you are satisfied, click **OK**. To return the system to the original sensitivity settings, click the **Default** button.

When you change the Sensitivity, a message will open up explaining that your calibration will be discarded (if you have Calibrated the sensor). If you want to continue, click **Yes**.



You then have the option to change the Sensitivity of the sensor.

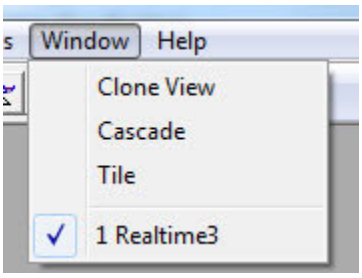



**Zeroing Preload:** This feature modifies the calibrated data to correct for residual pressure (referred to as the "Offset Load") on the sensor at zero load. This operation is useful if the sensor is under some load for the entire duration of the recording, or if the sensor must be secured in place by hardware which would cause load to be detected by the sensor. The raw data is not affected by the Zeroing Preload function, but an extra calculation is performed when converting the raw data to calibrated data. If the sensor is reading raw pressure, it is set at zero raw before the calibration scale factor is applied. Zeroing Preload is recommended only for single point calibration and may increase error when using a multi-point calibration.

**Configure WiFi Sensor:** Refer to The Wireless ELF System section.

## Window Menu

Window Menu (same when focus is on either a Real-time or Movie Window):

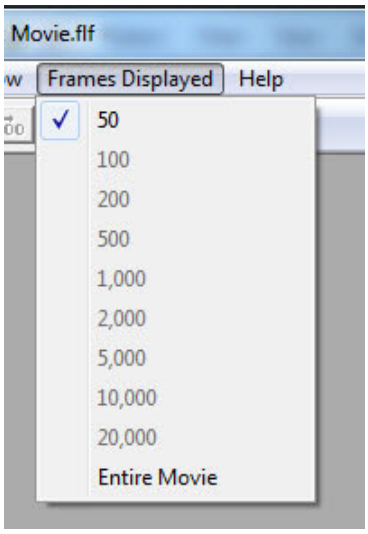



**Clone View:** Creates a copy of the currently selected window and opens it as a secondary window on-screen. This command is useful if you want to see the same sensor readout in multiple windows, for example, if you want to use the "Strip Chart" view for the sensors in one window and a "Column" or "Numeric" view for the sensors in a second window (all three options found under the View menu).

**Cascade:** arranges multiple windows in an overlapped fashion.

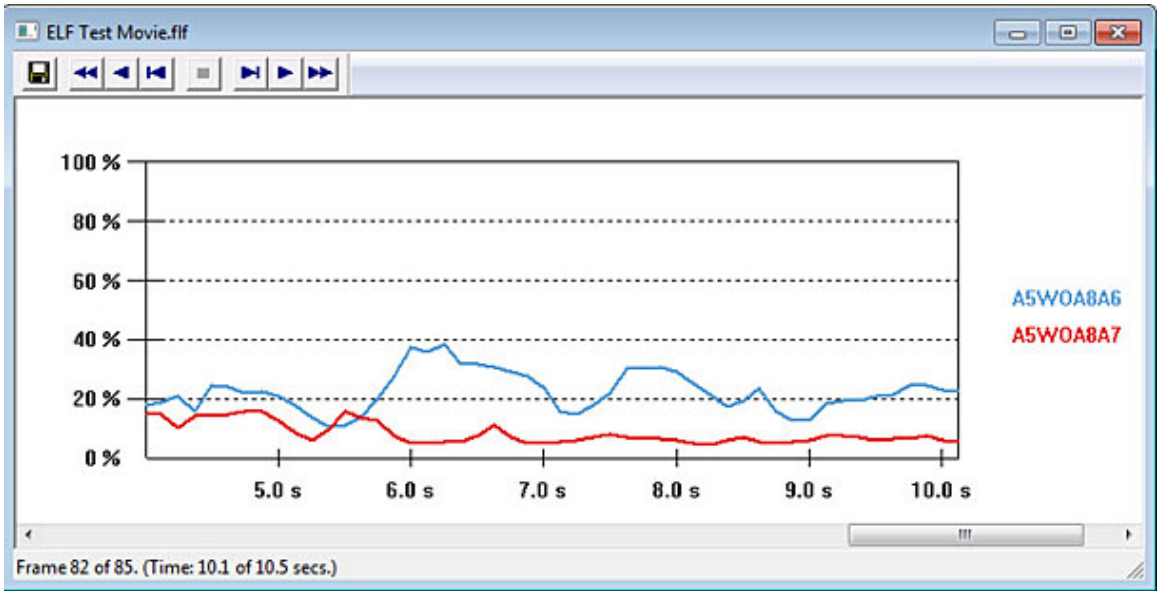
**Tile:** arranges multiple windows in an overlapped fashion, either vertically or horizontally.

## Frames Displayed Menu

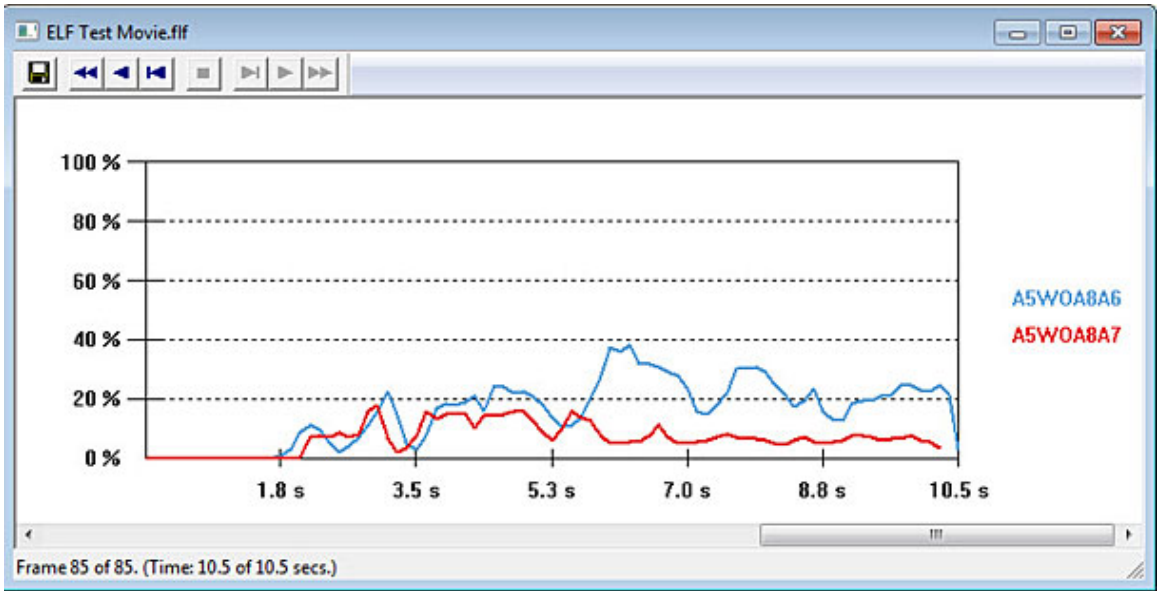



***Frames Displayed Menu (only available when focus is on a Movie Window):***

The Frames Displayed Menu provides various display options for the amount of frames shown within the Movie Window (along the X-axis). In addition, you can opt to view the **Entire Movie** within the window's display area.

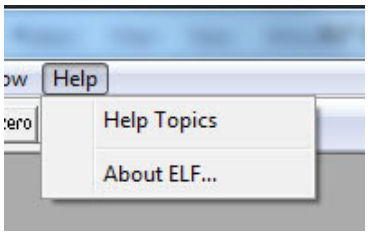



***50 frames within a movie.***




***The same movie as above, but this time with the Entire Movie option selected.***

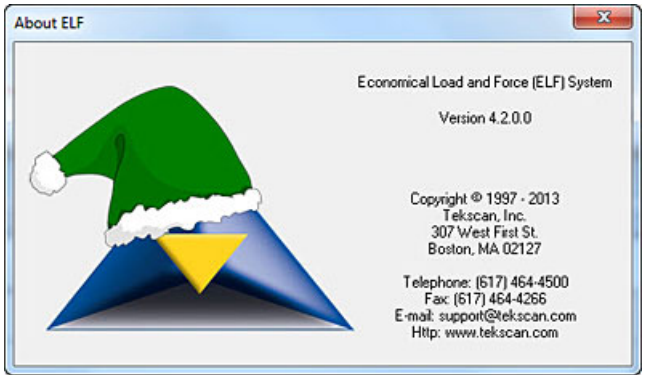
## Help Menu




***Help Menu (same when focus is on either a Real-time or Movie Window):***

**Help Topics:** opens the help file associated with the Multi-Channel ELF software.

**About ELF:** opens the *About ELF* dialog box, which displays the software and hardware (device) version numbers for your ELF system, and gives you information on how to contact Tekscan (shown below).



# SENSOR LOADING CONSIDERATIONS

The following general sensor loading guidelines can be applied to most applications, and will help you achieve the most accurate results from your tests. It is important that you read the ***Sensor Performance Characteristics*** section for further information on how to get the most accurate results from your sensor readings.

## Sensor Loading

The entire sensing area of the FlexiForce sensor is treated as a single contact point. For this reason, the applied load should be distributed evenly across the sensing area to ensure accurate and repeatable force readings. Readings may vary slightly if the load distribution changes over the sensing area.

***Note that the sensing area is the silver circle on the top of the sensor only.***

It is also important that the sensor be loaded consistently, or in the same way each time.

If the footprint of the applied load is smaller than the sensing area, the load should not be placed near the edges of the sensing area, to ensure an even load distribution. It is also important to ensure that the sensing area is the entire load path, and that the load is not supported by the area outside of the sensing area.

If the footprint of the applied load is larger than the sensing area, it may be necessary to use a "puck". A puck is a piece of rigid material (smaller than the sensing area) that is placed on the sensing area to ensure that the entire load path goes through this area. The puck must not touch any of the edges of the sensing area, or these edges may support some of the load and give an erroneous reading.

The FlexiForce sensor reads forces that are perpendicular to the sensor plane. Applications that impart "shear" forces could reduce the life of the sensor. If the application will place a "shear" force on the sensor, it should be protected by covering it with a more resilient material.

If it is necessary to mount the sensor to a surface, it is recommended that you use tape, when possible. Adhesives may also be used, but make sure that the adhesive will not degrade the substrate (polyester) material of the sensor before using it in an application. Adhesives should not be applied to the sensing area; however, if it is necessary, ensure that the adhesive is spread evenly. Otherwise, any high spots may appear as load on the sensor.

## Saturation

The **Saturation** force is the point at which device output no longer varies with applied force. The saturation force of each sensor is based on the maximum recommended force specified by Tekscan, which is printed on system packaging or the actual sensor, along with the "Sensitivity".

Sensors are available in three force ranges (**Low**, **Medium**, and **High**), which have specified maximum forces of 25, 150, and 1000 lbf, respectively. The sensor's effective force range (up to the specified maximum) can be altered by adjusting the system sensitivity (refer to the Calibration section). Decreasing the sensitivity setting (1 to 20 possible) will increase the force range (displayed as "Approx Max Range"), and "saturation" force, of the sensor, and vice versa.

***It is essential that the sensor(s) do not become saturated during testing.***

# Conditioning Sensors

Exercising, or **Conditioning** a sensor before calibration and testing is essential in achieving accurate results from your ELF system. It helps to lessen the effects of *drift* and *hysteresis*. Conditioning is required for new sensors, and for sensors that have not been used for a length of time.

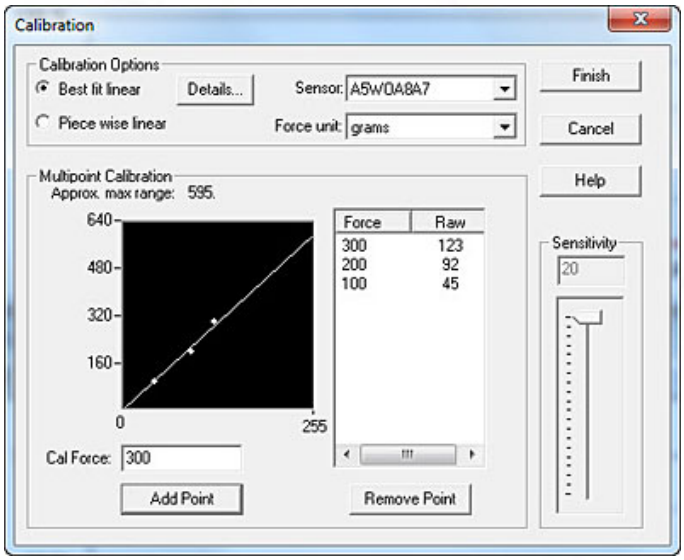
To condition a sensor, place 110% of the test weight on the sensor, allow the sensor to stabilize, and then remove the weight. Repeat this process four or five times. The interface between the sensor and the test subject material should be the same during conditioning as during calibration and actual testing.

***IMPORTANT! Sensors must be properly conditioned prior to calibration and use.***

# CALIBRATION

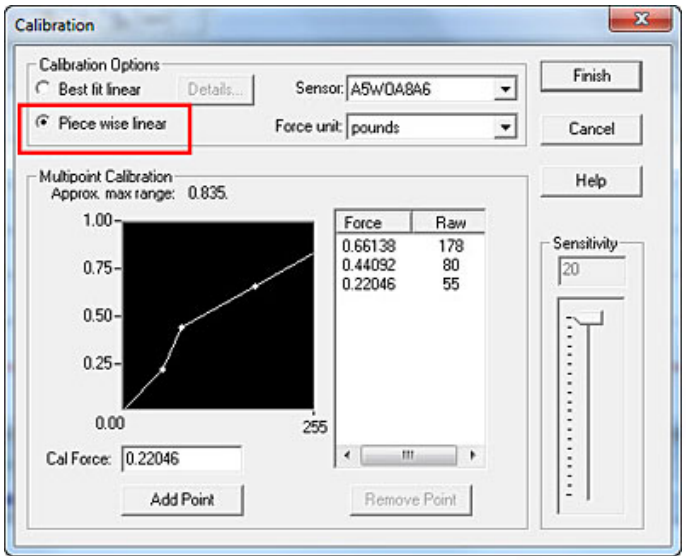
The ***ELF*** system sensor acts as a variable resistor in a circuit. This circuit produces a digital output value (between 0-255 Raw) based on the sensor resistance and the system handle's adjustable gain (sensitivity). **Calibration** is the method by which this digital output is related to an actual engineering unit, such as pounds or Newtons. If you are using the Multi-Handle ELF system, all selected COM ports must be calibrated with at least one point before Calibration can be completed.

To calibrate, apply a known force to the sensor. The software then equates this applied force to the digital output that it reads, and performs a linear interpolation between zero load and the known calibration load. In this way, the software determines the actual force range that matches the digital output range of 0-255 Raw.

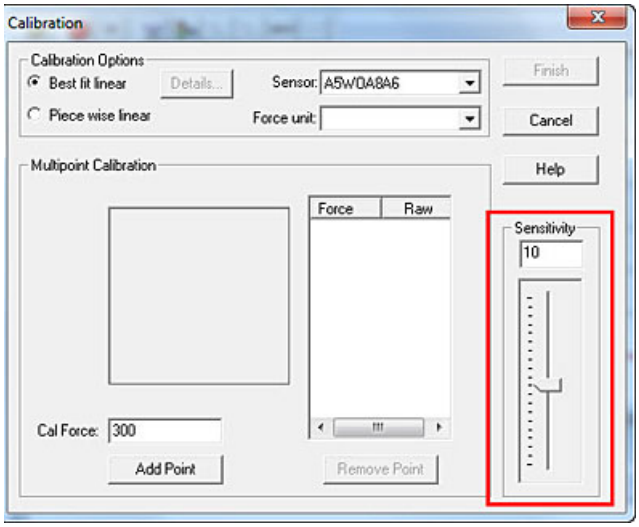



To perform a multi-point calibration, apply at least two known forces to a sensor. The software then equates this applied force to the digital output that it reads, and performs one of two types of interpolation between zero load and the known calibration loads. In this way, the software determines the actual force range that matches the digital output range of 0-255 Raw.

- **Best Fit Linear Calibration:** This calibration creates a best-fit curve through two or more known force values. After a known load is added as a calibration point, select the **Params** button for details about the calibration, including slope, offset and Correlation Coefficient (r2).
- **Piece Wise Linear Calibration:** This calibration connects each calibration point and interpolates between the values.



***NOTE: if you have a Multi-Handle ELF system, all handles must use the same type of calibration. Linear and Best Fit cannot be mixed and matched.***




The "Sensitivity" (or "Adjustable Gain") is also adjusted in the ELF *Calibration* dialog box. This adjustment sets the data output range from the computer (0 to 100%) to the actual force range output from the system handle. In this way, the usable force range of the sensor can be adjusted (up to the rated maximum force). "Sensitivity" settings are saved between sessions, and are included with calibration files.

# Calibration Guidelines

The following guidelines should be considered when calibrating a sensor:

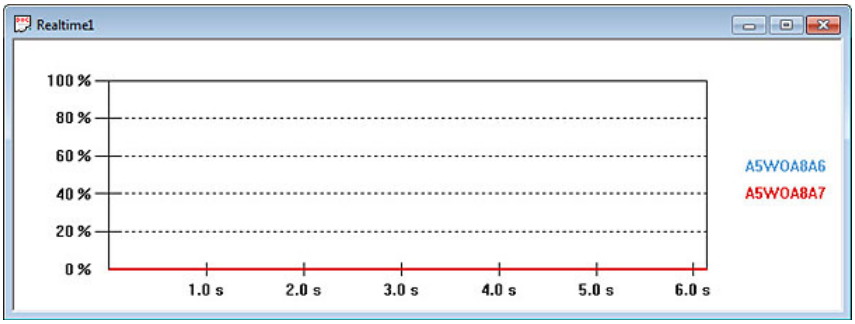
- Apply a calibration load that approximates the load to be applied during system use, using dead weights or a testing device (such as an ***MTS*** or ***Instron***). If you intend to use a "puck" during testing, also use it when calibrating the sensor. See Sensor Loading Considerations for more information on using a puck.
- Avoid loading the sensor to near saturation when calibrating. If the sensor saturates at a lower or higher load than desired, adjust the "Sensitivity".
- Distribute the applied load evenly across the sensing area to ensure accurate force readings. Readings may vary slightly if the load distribution changes over the sensing area.

***Note: Read the Sensor Performance Characteristics section before performing a Calibration.***

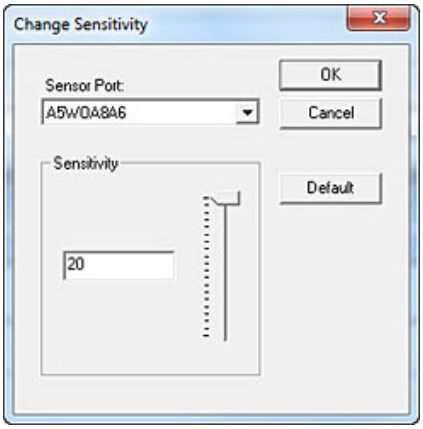
# Calibration Procedure

***IMPORTANT! Sensors must be properly conditioned prior to calibration and use.***

1. Select **File > New** to open a new Real-time window. If you wish to use a previously saved calibration file, from a Real-Time Window (shown below), select **Tools > Load Calibration**, enter the calibration file name and path, and click **OK.**

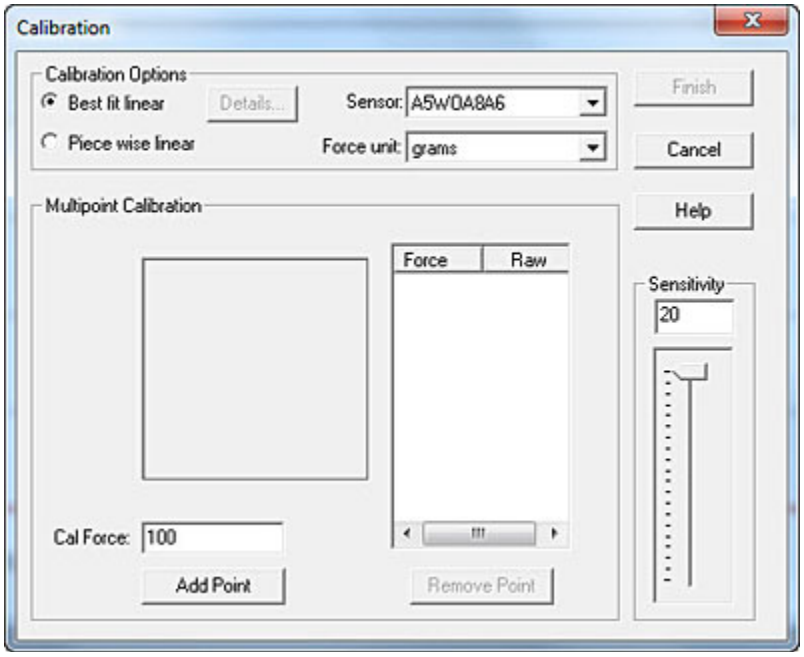


2. If, on the other hand, you wish to perform a Calibration, first load each sensor with a known force.

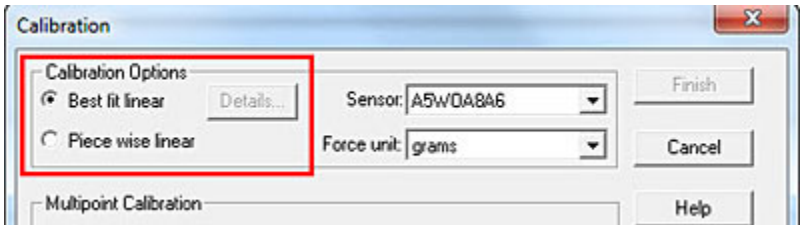



3. Click **Tools > Change Sensitivity** (shown at right). If you have the Multi-Handle ***ELF*** system, adjust sensitivity for each sensor, if necessary, by either dragging the slider up and down, or entering an integer between 1 and 20 (default is 12). The "Sensitivity" should be adjusted whenever necessary to keep the force display in a usable range.

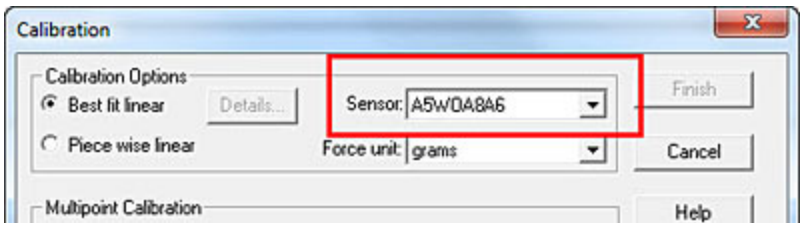
4. Click on Tools > Calibrate. This brings up the *Calibration* dialog box (shown below).



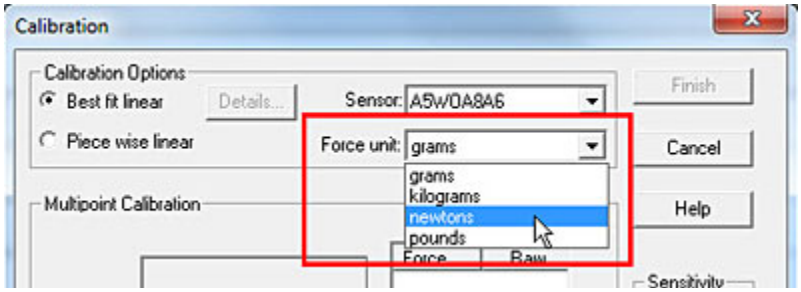

5. Select **Best Fit Linear** calibration or **Piece Wise Linear** calibration.




6. Select the **Sensor** you wish to calibrate first. If you have the Multi-Handle ELF system, all Sensors must be calibrated before you may select **Finish** (before you can finalize the calibration and exit the dialog box without Canceling)**.**

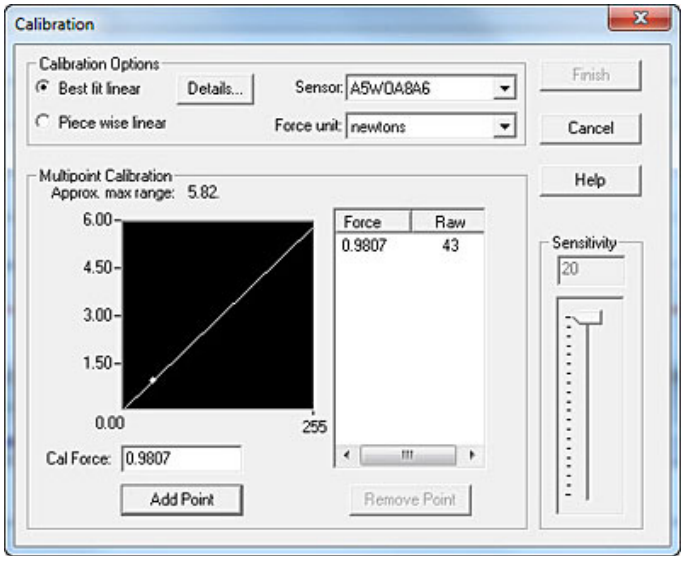



7. Select the appropriate **Force unit** from the drop-down box (grams, kilograms, Newtons, pounds).



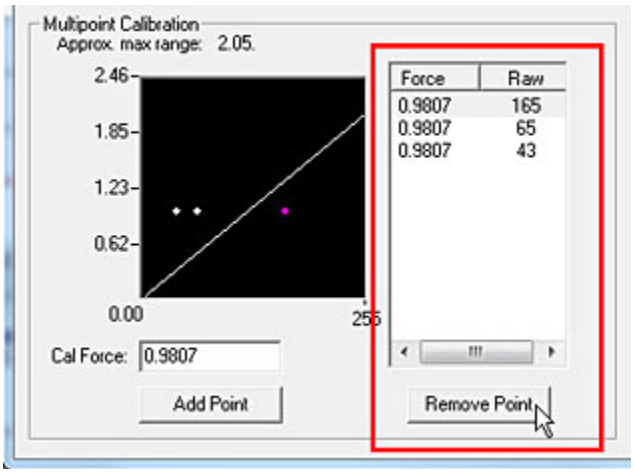

8. Load the sensor with a known force. The key to an accurate calibration is applying a stable load. Enter the known load in the **Cal Force** field. If the applied force is not stable, an error message will appear which requires you to either accept or cancel the current calibration. It is recommended that you stabilize the force; otherwise, your calibration may be inaccurate. In the example below, we have loaded the sensor with a 1-pound weight at 20%.

9. Click **Add Point**. A point will appear in the *Multipoint Calibration* box (shown below).



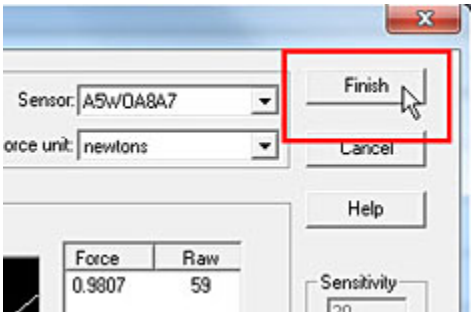
10. Repeat the steps with as many known loads as you wish.

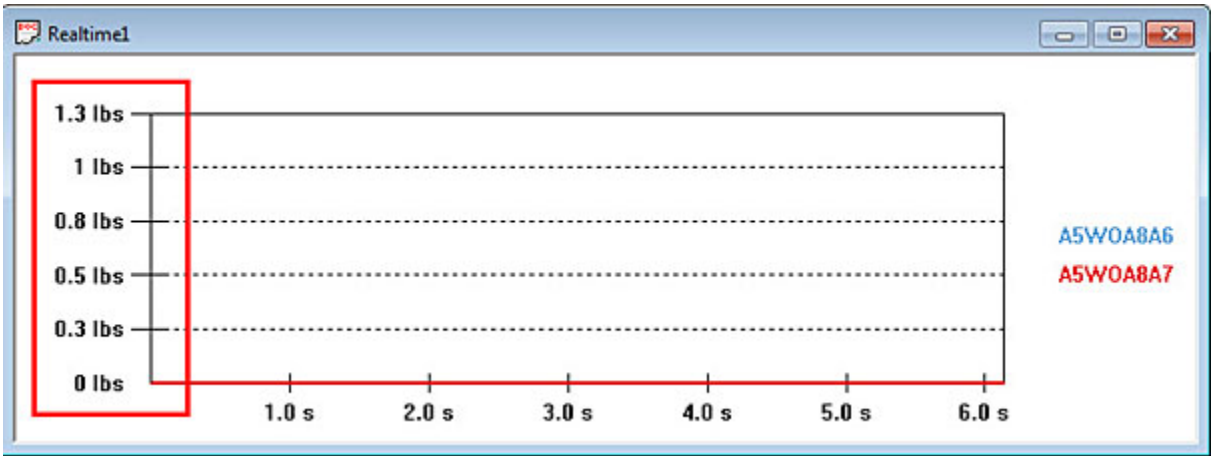
11. If you wish to discard any points, click to highlight them in the **Force/Raw** column. Then select **Remove Point**.



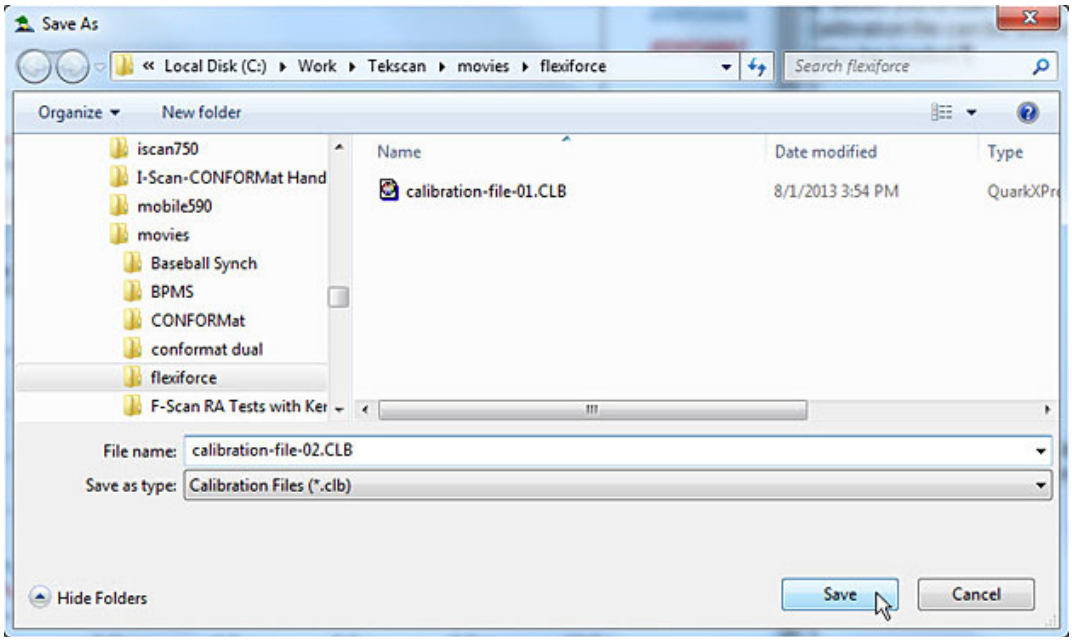

12. If you have the Multi-Handle ELF system, continue selecting **Sensor** and adding as many known loads as you wish, until at least one calibration point has been added for each sensor.

13. Once all Calibration points have been added for all **Sensors**, click **Finish**. The Real-time window will now display force in units of force rather than raw force.



14. If you wish to save the calibration file for future use, select **Tools > Save Calibration**, and enter the desired destination and file name in the *Save As* dialog box. Calibration files must be saved with the ***.clb** file extension. Sensitivity settings are saved with calibration files.




15. If you wish to recalibrate the sensor during the same testing session, you may either select **File > New** to get a new Real-time Window, or select **Tools > Uncalibrate** to reset the calibration of the current window. A calibration will be saved between sessions unless **Uncalibrate** is selected.

# SENSOR PERFORMANCE CHARACTERISTICS

There are a number of characteristics of sensors, which can affect your results. This section contains a description of each of these conditions, and recommendations on how to lessen their effects.

## Repeatability

**Repeatability** is the ability of the sensor to respond in the same way to a repeatedly applied force. As with most measurement devices, it is customary to exercise, or "condition" a sensor before calibrating it or using it for measurement. This is done to reduce the amount of change in the sensor response due to repeated loading and unloading. FlexiForce sensors are generally repeatable within +/- 2.5% once they have been conditioned. A sensor is conditioned by loading it to 110% of the test weight four or five times. Follow the full procedure in the **Conditioning Sensors** section.

## Linearity

**Linearity** refers to the sensor's response (digital output) to the applied load, over the range of the sensor. This response should ideally be linear; and any non-linearity of the sensor is the amount that its output deviates from this line. A calibration is performed to "linearize" this output as much as possible. FlexiForce sensors are linear within +/- 3%.

## Hysteresis

**Hysteresis** is the difference in the sensor output response during incremental step loading and unloading (without going back to zero between measurements), at the same forces. For static forces, and applications in which force is only increased, and not decreased, the effects of hysteresis are minimal. If an application includes load decreases, as well as increases, there may be error introduced by hysteresis that is not accounted for by calibration. For a conditioned sensor, with 50% of the full force range applied, hysteresis is less than 4.5 % of full scale.

## Drift

**Drift** is the change in sensor output when a constant force is applied over a period of time. If the sensor is kept under a constant load, the resistance of the sensor will continually decrease, and the output will gradually increase. It is important to take drift into account when calibrating the sensor, so that its effects can be minimized. The simplest way to accomplish this is to perform the sensor calibration in a time frame similar to that which will be used in the application. In ***FlexiForce*** sensors, drift is less than 3% per logarithmic time.

## Temperature Sensitivity

The operating range for ***FlexiForce*** sensors is from 15°F (-9°C) to 140°F (60°C). FlexiForce sensor output may vary up to +/- 0.2% per change in degree F (approx. +/- 0.36% per change in degree Celsius). In general, this effect will be more significant if you combine high loads on the sensor with high temperatures. For loads of less than 10 lbs., the operating temperature can be increased to 165°F (74°C).

To ensure accuracy, calibrate the sensor at the temperature at which it will be used in the application. If the sensor is being used at different temperatures, perform a calibration at each of these temperatures, save the calibration files, then load the appropriate calibration file when using the sensor at that temperature.

FlexiForce sensors should be stored at temperatures in the range of 15°F (-9°C) to 165°F (74°C).

## Sensor Life / Durability

Sensor life depends on the application in which it is used. Sensors are reusable, unless used in applications in which they are subjected to severe conditions, such as against sharp edges, or shear forces. FlexiForce sensors have been successfully tested at over one million load cycles using a 50 lb. force.

Rough handling of a sensor will also shorten its useful life. For example, a sensor that is repeatedly installed in a flanged joint will have a shorter life than a sensor installed in the same joint once and used to monitor loads over a prolonged period. After each installation, visually inspect your sensors for physical damage.

It is also important to keep the sensing area of the sensor clean. Any deposits on this area will create uneven loading, and will cause saturation to occur at lower applied forces.

# THE WIRELESS ELF SYSTEM

The Wireless Economical Load Force 2 (WELF 2) system is a user-friendly, cost-effective load measurement system. This system combines FlexiForce sensors, Wireless ELF electronics, and Windows-compatible software, turning your PC or laptop into a force measurement instrument. The Wireless ELF 2 system allows you to transmit force readings from your FlexiForce sensors to your PC without a direct cable connection. The following section explains the setup and operation of this system. Key Features include:

- Real-time data capture
- ASCII output to data analysis software
- Simple and storable calibration
- Adjustable sensitivity
- Multiple Handle capability available
- Displays in strip chart, column graph, or digital readout
- Wireless connection setup: "Ad-Hoc" and "Access Point" (router) network capability
- Connector: Compatible with all FlexiForce 2- and 3-pin male sensors
- Movie recording & saving
- Multi-point calibration
- Capability to tare a load
- Internal triggering
- Sampling rate up to 200 Hz
- High-speed version available, up to 6,000 Hz
- WiFi certified 802.11b radio - 802.11b/g/n compatible

## Component Identification

Following are the components that ship with the Wireless ELF 2 system. For a list of components that ship with the ELF or Multi-Handle ELF system, refer to the ELF Component Identification section.

| ***(1) WELF Transmitter*** | ***(1) AC Adapter (Optional)*** |
|---|---|
| | |

Also Included:

**(3) FlexiForce WB201 Sensors**

**(3) AAA Batteries & (1) Phillips head #1 screwdriver**

***Note: You can use a 2-pin sensor with the WELF Transmitter; however, you must ensure that the two pins are connected to the right side pin connections (the two pins closest to the On/Off Power Switch).***

# Technical Specifications

The WELF Transmitter is powered via three AAA alkaline batteries (such as Energizer #E92), or the optional AC Adapter can be used if operation of the product is for extended period of time to save on battery life. The following provides some guidance on expected performance:

Notes about the batteries used with the WELF Transmitter:

- These batteries are primary cells and are not rechargeable.
- Use only alkaline batteries. Do not use any other kind of battery. Use of other types of batteries may damage the WELF Transmitter.
- Once the batteries are discharged, replace them with fresh batteries and dispose of the discharged batteries in accordance with applicable laws.
- If the WELF Transmitter is not to be used for an extended period of time, remove batteries. This avoids damage to the Transmitter if batteries leak.
- Use only Tekscan approved AC adapters, cables, and sensors.

**Sensors**

| Sensor | High Gain Maximum Force | Low Gain Maximum Force |
|---|---|---|
| WB201-L | 0 to 1 lb (4.4 N) | 0 to 25 lb (111 N) |
| WB201-M | 0 to 25 lb (111 N) | 0 to 150 lb (667 N) |
| WB201-H | 0 to 150 lb (667 N) | 0 to 1,000 lb (4,448 N) |

The following table provides sensor performance recommendations:

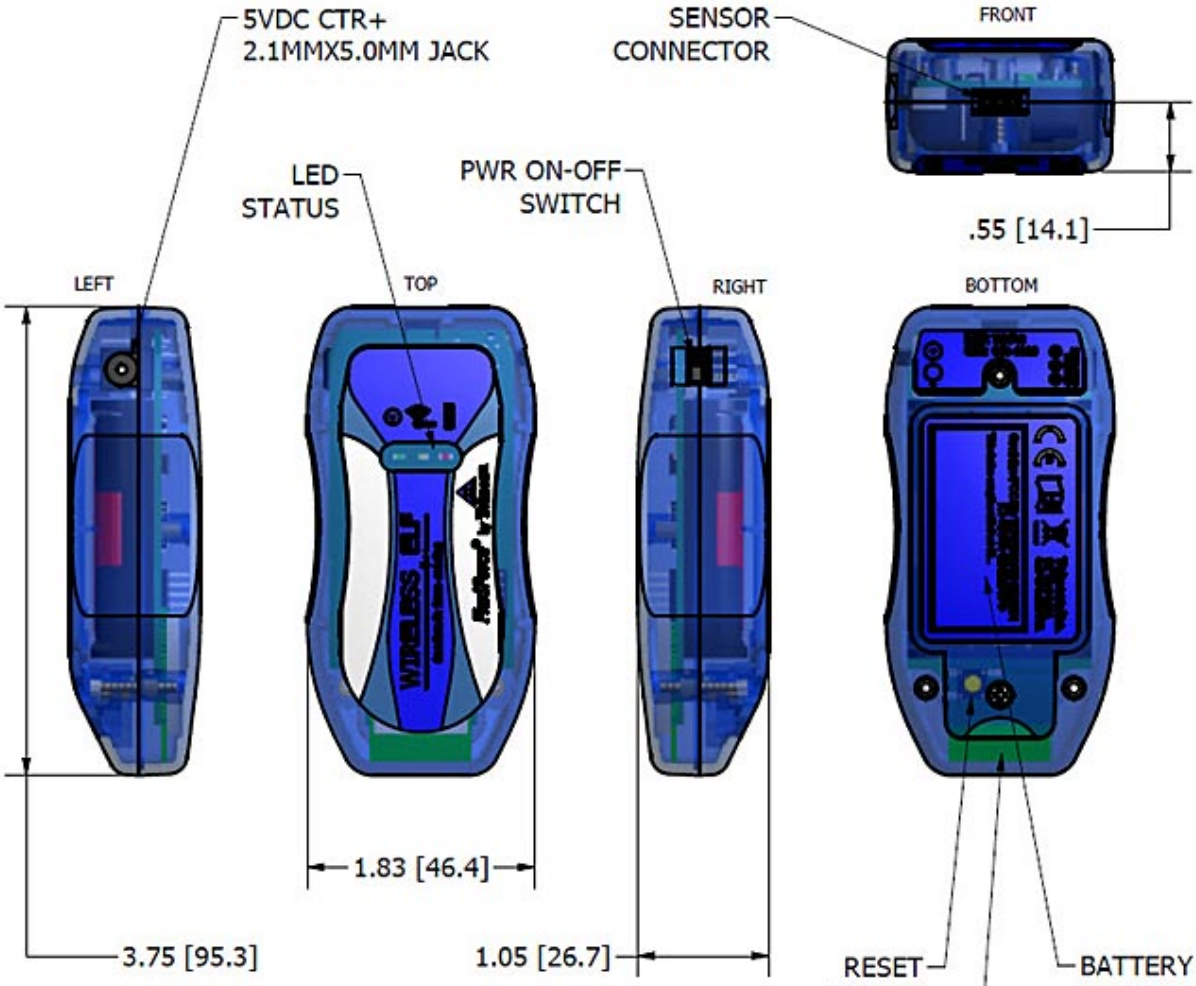
| Number of Handles | Scan Rate (Hz) | Distance (meters) |
|---|---|---|
| 16 (*WELF 2* - basic system) | 200 | 50 |
| 8 (*WELF 2* - High Speed system) | 6,000 | 25 |

***Note: You can use a 2-pin sensor with the WELF Transmitter; however, you must ensure that the two pins are connected to the right side pin connections (the two pins closest to the On/Off Power Switch).***

**WELF Features**

- **On/Off Power Switch:** Turns the WELF Transmitter on or off. The switch is located on the right of the Transmitter (refer to Sensor Specifications table below).
- **Sensor Input:** WB201 can be inserted via three-pin sensor connection into the WELF Transmitter. Sensor input is located at the front of the Transmitter (refer to Sensor Specifications table below).
- **LED Lights:** Three LED lights are located on the top-front of the WELF Transmitter (refer to Sensor Specifications table below). The available lights behave in the following way:
    - **Power Light:** Blinks green to indicate the WELF Transmitter is powered.
    - **Wireless Transmitter Light:** Blinks yellow to indicate the WELF Transmitter is transmitting wirelessly
    - **Battery Light:** Blinks red to indicate battery life is low. Blinking will increase in frequency as battery life is drained.

**Sensor Specifications**




NOTES:

1) DEVICE WEIGHT IS 3.3 OZ (95 G)
2) USE AAA ALKALINE 1.5V BATTERIES ONLY
3) BATTERY OPERATING LIFE IS TBD
4) SENSOR CONN ACCEPTS 2 AND 3 PIN STAKED SENSORS

**Specifications Table**

| **Software Compatibility** | |
|---|---|
| Windows 2000, XP, Vista, 7 | |
| | |
| **Sensor Properties** | |
| Thickness | 0.008" (0.208 mm) |
| Length | 9" (228.6 mm) end-to-end |
| Width | 0.55" (14 mm) |
| Sensing Area | 0.375" (9.53 mm) diameter |
| Substrate | Polyester (ex: Mylar) |
| | |
| **Sensor Performance** | |
| Linearity (Error) | < +/- 3%; Line drawn from 0 to 50% load |
| Repeatability | < +/- 2.5% of Full Scale; Conditioned sensor, 80% of full force applied |
| Hysteresis | < 4.5% of Full Scale; Conditioned sensor, 80% of full force applied |
| Drift | < 5% per Logarithmic Time Scale; Constant load of 25 lb (111 N) |
| | |
| **Electrical Specifications** | |
| WELF Unit (Transmitter - WLF-2) | 5 VDC, 200 mA MAX |
| AC Adapter: | 100 - 240 VAC.; 50 Hz. - 60 Hz.; 0.3 A. Output: 5VDC; 2.0 A. |
| AC Adapter Plug Polarity | Center Positive |
| | |
| **Battery** | |
| 3 AAA alkaline batteries | Up to 5 hours battery life |
| | |
| **Environmental Conditions** | |
| Temperature: $^{o}$F ($^{o}$C) | 15 to 140 (-9 to 60) Prolonged use at higher end of temperature range should be avoided |
| Humidity: % | 0 to 90 (non condensing) |
| Pressure: psi (kPa) | 1.7 to 14.7 (11.6 to 101.3) (sea level to 50,000 ft) |

# Installing the Batteries

To insert the batteries into the WELF Transmitter, follow the procedure below:

1. Using the small Phillips head #1 screwdriver, unscrew the center screw located on the bottom rear of the Transmitter, being careful not to strip the screw when loosening. Remove the screw from the battery access door located on the bottom of the Transmitter (shown below).

2. Lift and remove the battery access door using the thumb notch to reveal the batteries inside the Transmitter. Replace the three AAA batteries with a new set.

4. Place the battery access door back onto the Transmitter. Insert and screw the battery access door in place. As you tighten the screw, be careful not to strip the threads.

# Setting up the Wireless ELF System

### Software Installation

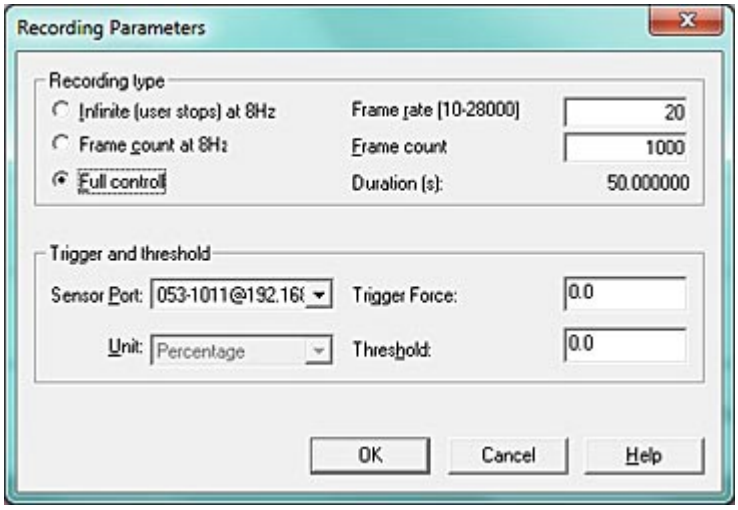
The "ELF" and "WELF 2" Systems follow the same software installation procedure. Please refer to the Software Installation section for proper instructions.

***The "WELF 2" software splash screen***

ELF™
ECONOMICAL LOAD & FORCE SYSTEM
Data Acquisition System from Tekscan, Inc.
Tekscan, Inc. is an ISO 9001 registered company

### Wireless Setup

There are two methods to setup the Wireless system. The "Ad-Hoc" method is the default setting for new WELF Transmitters, and is appropriate if you plan to use one Transmitter at a time. The second "Access Point" method is recommended if you are connecting multiple Transmitters together, and uses a wireless router to connect the Transmitters. The following explains both of these setups. Note that Windows 7 is used for the instructions below. Other Windows operating systems may vary slightly in setup.



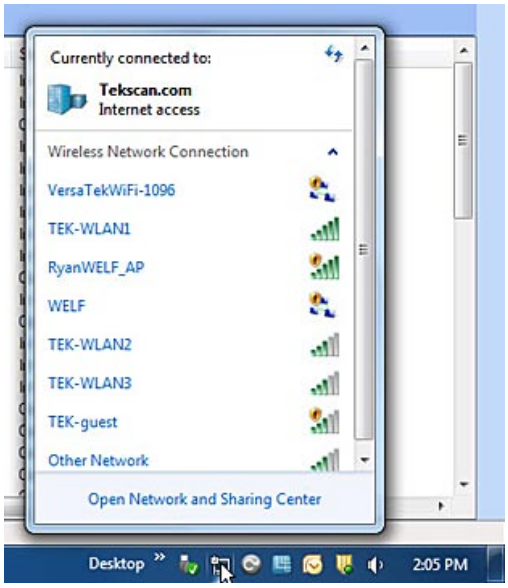

Note also that the Recording Parameters are slightly different for WELF 2 systems than for ELF systems. The following shows the Recording Parameters for WELF 2, which is all contained on a single screen. To access these parameters, go to **Record > Settings** while you have a new recording open on-screen. The following dialog opens, where you can select the Recording Type and Frame Rate for the WELF Transmitters.

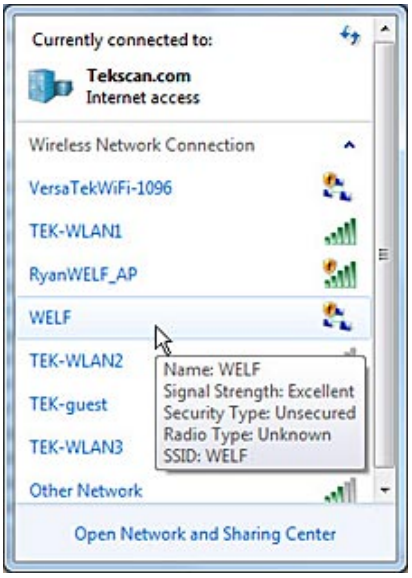
**Setting up an Ad-Hoc Network**

***Note: "Ad-Hoc" mode is the default mode for the WELF Transmitters.***

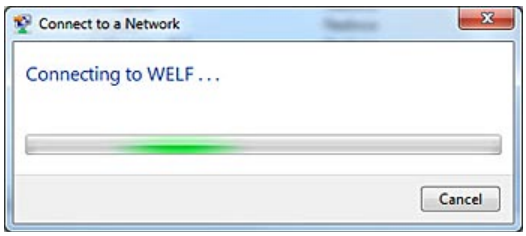
Ensure your computer is capable of wireless transmission. Consult your computer's documentation for more information.

1. Turn on the WELF Transmitter using the On / Off power switch located on the right side of the unit (shown at right).
2. Click the wireless icon in the lower right Windows taskbar, as you would if you were connecting to a wireless network. Select the "WELF" network (shown in the images below).



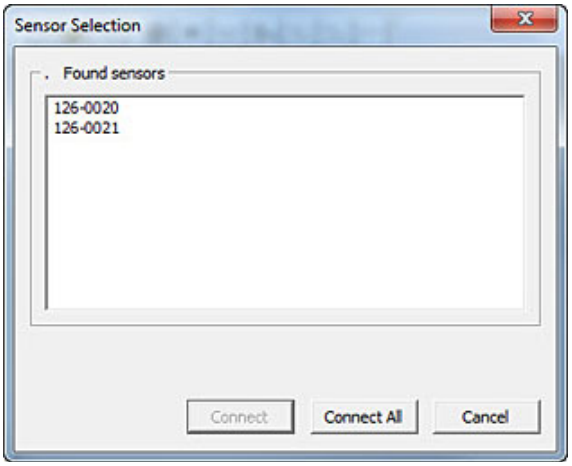



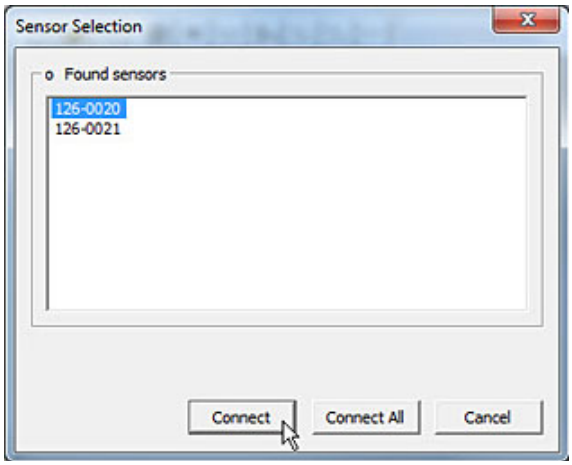

3. Double-click the "WELF" network to expand it and then click on the **Connect** button (shown below left). A window indicates your computer is connecting to the "Ad-Hoc" network (shown below middle). This may take a moment. Once finished, the "WELF" network indicates "Connected" (shown below right).



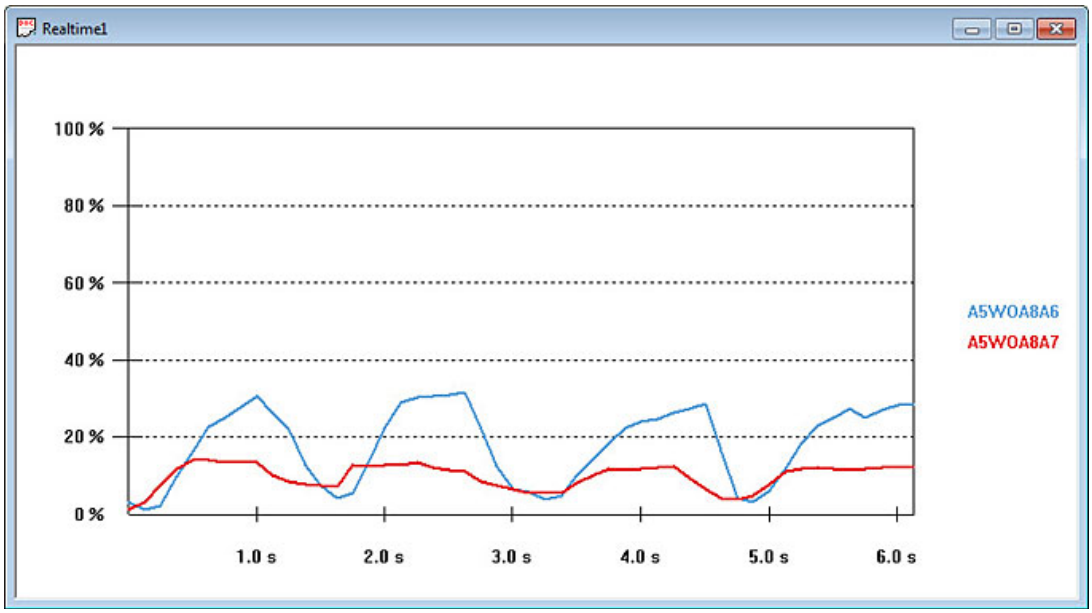
4. Open the WELF 2 software by clicking on the WELF 2 icon (shown at right) on your desktop, or under your "Program Files" from the Windows Start button (located at the lower left of your computer screen).

5. When the software opens, the “Sensor Selection” window is displayed on your computer screen (shown below left). Select the sensors you would like to have connected to the current Real-Time Window (using **Ctrl+Click** to select multiple sensors), and click the **Connect** button (shown below right). If you wish to connect to all sensors, you do not have to first select any sensors. Simply click the **Connect All** button. See the Sensor Selection section for more information about this dialog.

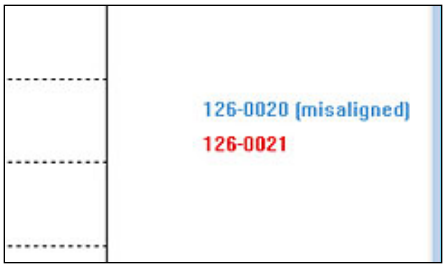



The "Wireless Sensor Connection" dialog closes and a new Real-time window opens where you can monitor the sensor's force data (shown below).

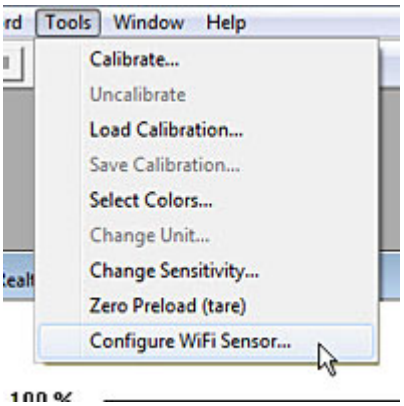


If the sensor is misaligned in the Handle, the label indicates the misalignment (shown at right). Remove and reinsert the sensor into the Handle to ensure it is working correctly. If the sensor is inserted properly into the Handle, and the software still indicates it is misaligned, contact Tekscan for assistance.



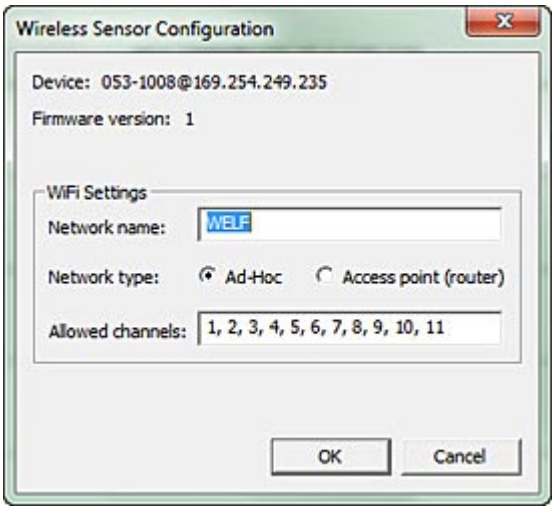

**Setting up an Access Point network**

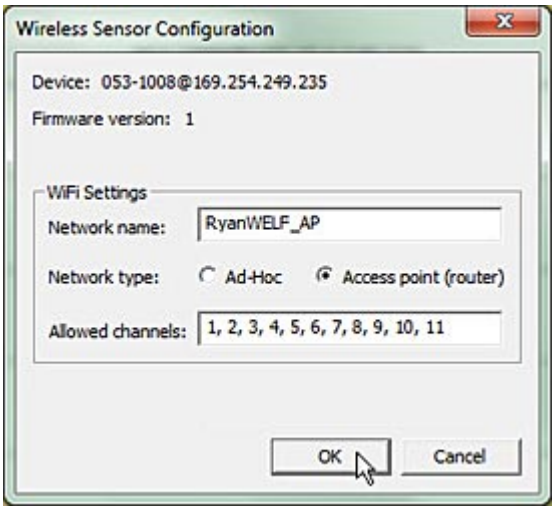
***Note: The router must be non-encrypted, and dedicated for use with the "WELF 2" system. Personal and public networks will not work if they are encrypted.***




1. Follow steps 1-5 above (Setting up an "Ad-Hoc" Network).
2. Go to **Tools > Configure WiFi Sensor** (shown at right).
3. The "Wireless Sensor Configuration" dialog opens (shown below left). Enter the name of the router (SSID) in the "Network Name" field, and select **Access point (router)** as the "Network Type" (shown below right). Then press the **OK** button to accept the changes and close the dialog.

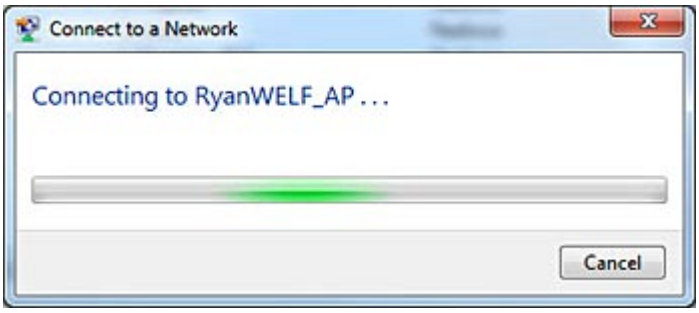
***Note: If you incorrectly type in the Network name and press "OK," you will have to reset the WELF Transmitter. Refer to the Resetting the WELF Transmitter to the Default "Ad-Hoc" Network section for information on how to do this.***



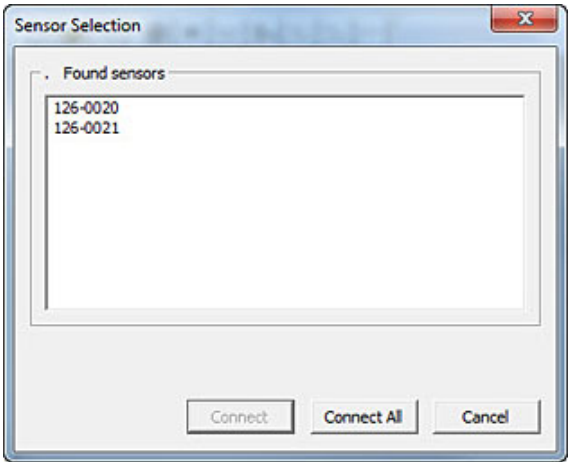



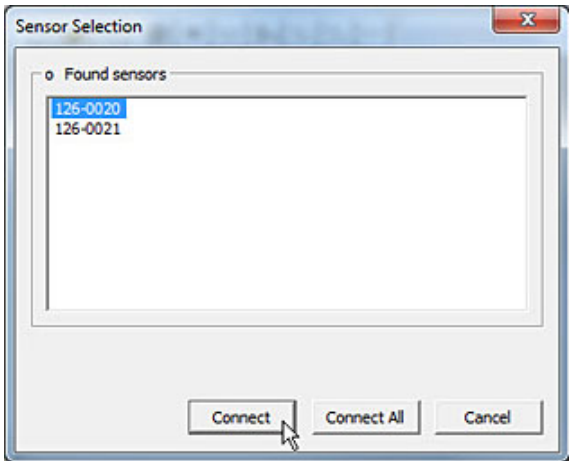

4. Exit the software and turn the WELF Transmitter off and then on again. (Optional) Repeat steps for each additional WELF Transmitter you wish to connect.

5. Connect the PC to the router you specified in the software by clicking on the wireless icon in the lower right taskbar. Expand the proper router network you specified earlier, and click the **Connect** button (shown below left). A window indicates your computer is connecting to the "Access Point" network (shown below right). This may take a moment. Once finished, the network status indicates "Connected."

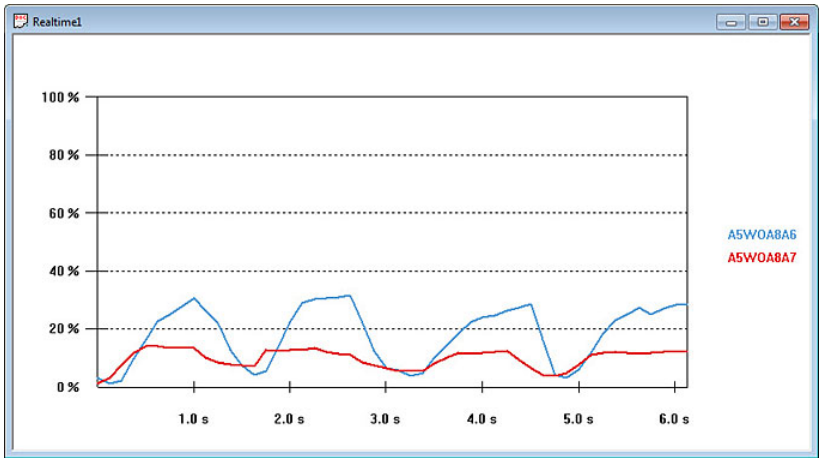



6. Turn on the WELF Transmitter(s) and open the software. The “Sensor Selection” window is displayed on your computer screen (shown below left). Select the sensors you would like to have connected to the current Real-Time Window (using **Ctrl+Click** to select multiple sensors), and click the **Connect** button (shown below right). If you wish to connect to all sensors, you do not have to first select any sensors. Simply click the **Connect All** button. See the Sensor Selection section for more information about this dialog.



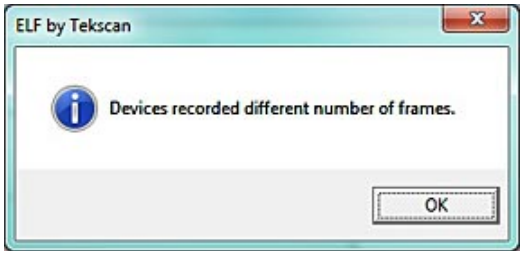



The " Sensor Selection" dialog closes and a new Real-time window opens where you can monitor the sensors' force data (shown below).

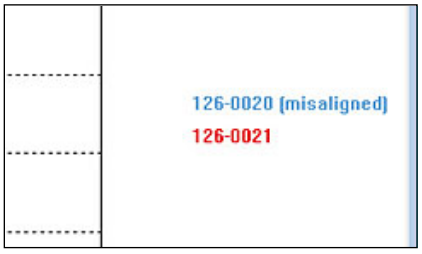



***Note: If you wish to rename a Transmitter, double-click on the Serial number for the Transmitter you want to rename (shown on the right side of the Real-time window above). Then enter your name for the channel in the "Name" dialog that opens.. Names are saved along with the recording, and are even saved across sessions if you close and reopen the software. If you wish to revert to the serial number again, double-click and leave the name field empty in the "Name" dialog.***

***Note: If a Transmitter drops out for a time, you will receive the following prompt on-screen. This is because some Transmitters transmit more data (more frames) than the one that dropped out. However, all the data for all Transmitters is still recorded. Only the data for the Transmitter(s) that dropped out will not be recorded for the duration of the drop-out. This can probably most easily be seen if you convert the data to ASCII data (File > Save ASCII).***




If the sensor is misaligned in the Handle, the label indicates the misalignment (shown below). Remove and reinsert the sensor into the Handle to ensure it is working correctly. If the sensor is inserted properly into the Handle, and the software still indicates it is misaligned, contact Tekscan for assistance.



# Resetting the WELF Transmitter to the Default "Ad-Hoc" Network

If you have set up the WELF Transmitter to be used in an "Access Point" network, and wish to return the unit to the default "Ad-Hoc" network settings, follow the instructions below:

1. Using the small Phillips head #1 screwdriver, unscrew the center screw located on the bottom rear of the Transmitter, being careful not to strip the screw when loosening. Remove the screw from the bottom battery access door (see image at right).
2. Lift and remove the battery access door using the thumb notch.

3. Turn on the Transmitter.
4. Using an object such as a pen, press and hold the Reset button (shown below) until all three LED lights simultaneously illuminate on the front of the Transmitter. When they do, release the Reset button.

5. Place the battery access door back onto the Transmitter again. Insert and screw the battery access door in place. As you tighten the screw, be careful not to strip the threads.
6. Turn the Transmitter off and then on again. The Transmitter is now set to the default "Ad-Hoc" network setting.

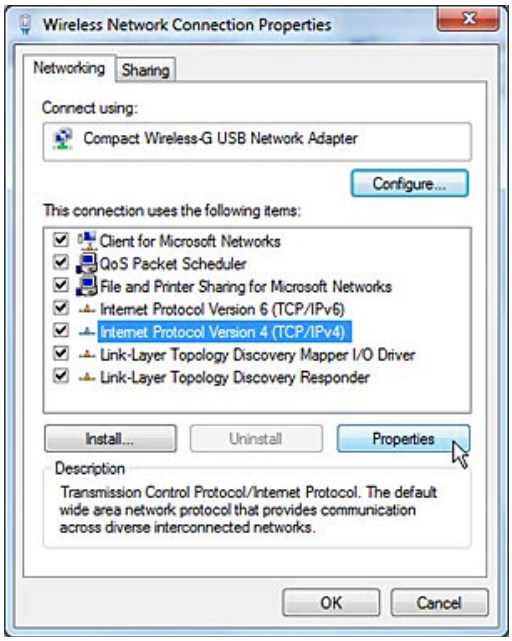
# Equipment maintenance

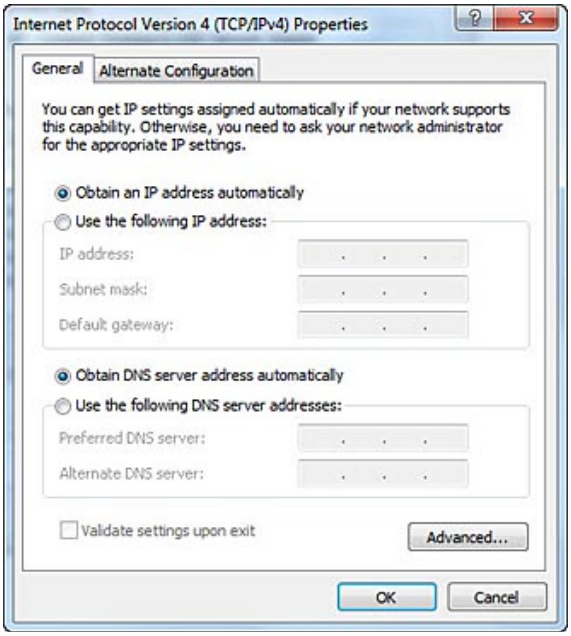
- The WELF Transmitter cannot be autoclaved.
- Do not let any liquid drip onto the electronics inside the WELF Transmitter. If this occurs, it may stop working and must be allowed to dry for 24 hours. You can use an air syringe, however, to significantly reduce this drying time. Do not attempt to dry out the WELF Transmitter using any other method, or you may destroy the delicate electronics.
- To properly clean the WELF Transmitter, be sure to wipe it down with a 70% Isopropyl Alcohol solution. To do this, slightly dampen a cloth with the alcohol solution, careful not to soak or saturate the cloth. Then wipe the WELF Transmitter after each use.

# Troubleshooting

If you are having problems, try some of the following solutions. If this does not solve your problem, contact Tekscan Customer Service.

- Try turning off your wireless internet connection. The WELF 2 system may be experiencing interference with the wireless internet signal.
- Low battery life can result in connection problems. A blinking battery light indicates if battery strength is low. To test if this is causing the connection issue, plug the optional AC adapter into the WELF Transmitter, if you have obtained one, to power the unit via external power, or replace the batteries in the Transmitter.
- You may have your wireless adapter set to "Static IP," which is not supported. To change these settings, go to **Start > Control Panel > Network and Sharing Center**, and click on the "Change adapter settings" from the left side menu options. Then, right-click on the "Wireless Network Connection" icon and select "Properties" from the context menu. Select the "Internet Protocol Version 4 (TCP/IPv4)" setting and click the **Properties** button (shown below left). In the "Internet Protocol Version 4" properties dialog, ensure the "Obtain an IP address automatically" option is selected (shown below right). Then press the **OK** button to accept the changes and exit the dialog.





Internet Protocol Version 4 (TCP/IPv4) Properties
General
Alternate Configuration
You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.
Obtain an IP address automatically
Use the following IP address:
IP address:
Subnet mask:
Default gateway:
Obtain DNS server address automatically
Use the following DNS server addresses:
Preferred DNS server:
Alternate DNS server:
Validate settings upon exit
Advanced...
OK
Cancel

# GLOSSARY

## A

**About Elf (Help Menu):** The "About Elf" command displays a dialog window with information about the software version, as well as contact information for Tekscan.

**Adjustable Gain:** See "Sensitivity".

## B

**Best Fit Linear Calibration:** This calibration creates a best-fit curve through two or more known force values. After a known load is added as a calibration point, select the "Params" button from the Calibration dialog for details about the calibration, including slope, offset and Correlation Coefficient (r2).

## C

**Cal Force:** A value that is entered by the user on the Calibration dialog box. This value is the calibration load that is placed on the sensor in order to convert the Digital output into Engineering Units.

**Calibrate (Tools Menu):** The "Calibrate" command opens the 'ELF Calibration' dialog box, which enables you to calibrate the sensor and adjust the system sensitivity. See "Calibration".

**Calibration:** Calibration is the method by which this digital output of the sensor is related to an actual engineering unit, such as pounds or Newtons. If you are using the Multi-Handle ELF system, all selected COM ports must be calibrated with at least one point before Calibration can be completed.

**Cascade (Window Menu):** The "Cascade" command arranges multiple windows in an overlapped fashion.

**Change Sensitivity (Tools Menu):** The "Change Sensitivity" command opens the Sensitivity Dialog box. You may adjust the sensitivity for each sensor/COM port. Use the drop down Select Buttons field to select the COM port. Then drag the slider up and down until you are satisfied. Adjust as many buttons as you like. When you are satisfied, click OK. To return the system to the original sensitivity settings, click the Default button. See "Sensitivity".

**Change Unit (Tools Menu):** The "Change Unit" command allows you to quickly change the force units displayed in all windows. To use this feature, however, you must have performed a calibration. Otherwise, all force will be displayed as raw values.

**Close (File Menu):** The "Close" command causes the currently active Real-time or Movie window to close. If a movie has been recorded, but not saved, the software gives the option of saving the movie file.

**Column (View Menu):** The "Column" option displays each COM port individually, with force value displayed on the Y-Axis. Each column is color-coded to indicate the individual COM ports. As time elapses, the columns indicate changes in force.

**COM Port:** The hardware which connects the sensor to your computer. Each sensor is designated a COM Port on your PC. When you open a new Real-Time Window, you must select the Ports that are to be displayed in your Real-Time Window (such as COM 4, COM 5, etc.)

**Conditioning:** Exercising the sensor prior to Calibration and use. To ensure the most accurate results, it is always recommended to condition the sensor by placing 110% of the test weight on the sensor, allowing it to stabilize, and then removing the weight. This process should then be repeated four or five times. Conditioning your sensors helps lessen the effects of "Drift" and "Hysteresis", and is required for new sensors or sensors that have not been used for a length of time.

**Copy (Edit Menu):** The "Copy" command saves the current Real-time or Movie frame to the MS Windows clipboard. This data is saved in the clipboard as a graphic (bitmap) image of the current window. Once copied to the clipboard, this data can be pasted into other Windows applications by selecting Edit>>Paste.

## D

**Drift:** Drift is the change in sensor output when a constant force is applied over a period of time. If the sensor is kept under a constant load, the resistance of the sensor will continually decrease, and the output will gradually increase. It is important to take Drift into account when calibrating the sensor, so that its effects can be minimized. The simplest way to accomplish this is to perform the sensor calibration in a time frame similar to that which will be used in the application. In FlexiForce sensors, drift is less than 3%/logarithmic time.

**Duration:** Refers to a setting within the Recording Parameters dialog box. The Duration is listed below the 'Recording Type'; it will either say 'Until Stop' if Infinite is selected, or the approximate duration (in seconds) the recording will take to complete if Frame Count is specified. See "Recording Parameters".

## E

**ELF Hardware:** The ELF hardware consists of the sensor handle(s), ELF software, and the FlexiForce sensor(s).

**ELF Software:** The ELF software is an 8-bit application that is compatible with Microsoft (MS) Windows 2000/XP/Vista. The software allows you to view a graphical representation of the force on the sensor in real time, record this information as a 'movie', and review and analyze it later. There are a number of options for displaying the Real-time force data; it can be displayed as a strip chart, column graph, or digital readout. Recorded 'movie' frames can be saved as ASCII (text) files, which can be imported into a spreadsheet program, or opened in a text editor or word processing program. Real-time data or movie frames can also be copied to the Windows clipboard and pasted into other applications as a ".bmp" (bitmap) file.

## F

**Fast Recording:** Refers to one of the Recording Parameter options. When Fast Recording, is selected, the 'Frames to Record' may be entered, and the Recording Frequency (Hz) may be selected to the right. In Fast Recording applications, recordings can be obtained at user-defined frequencies between 10 and 200 Hz (standard system). For the High-Speed ELF system, frequencies as high as 5.7 kHz can be obtained. See "Recording Parameters".

**First Frame (Movie Toolbar Playback Controls):** Positions the recording at the beginning (First Frame).

**Focus:** The currently selected Window within your ELF software. Only one window can be selected at a time. A window is selected by clicking on it, and when selected, the title bar will turn blue. When a window is selected in this manner, it is said to have "focus".

**Frame Count:** Refers to one of the Recording Parameter options. When selected, the number of 'Frames to Record' may be entered at the bottom of the dialog box. The recording will stop when this number of frames has been recorded, regardless of the duration of the movie. See "Recording Parameters".

**Frames Displayed:** A submenu of the Main Menu. The Frames Displayed Menu provides various display options for the amount of frames shown within the Movie Window (along the X-axis). In addition, you can opt to view the "Entire Movie" within the window's display area.

## H

**Handle:** The handle is a piece of hardware that gathers data from the sensor, processes it, and sends it to your computer through a USB port. See "ELF Hardware" and "COM Port".

**Help Topics (Help Menu):** The "Help Topics" command opens the help file associated with the Multi-Channel ELF software. About ELF opens the About ELF dialog box, which displays the software and hardware (‘device’) version numbers for your ELF system, and gives you information on how to contact FlexiForce.

**Hi-Speed Recording Parameters:** Refers to the options available under the Recording Parameters dialog box. If you have purchased the ELF Hi-Speed system, the software will record at a higher range of speeds, and your Recording Parameters dialog box will look slightly different. Your choices for Recording Type include Infinite, Frame Count, and High Speed. See "Recording Parameters".

**Hysteresis:** Hysteresis is the difference in the sensor output response during incremental step loading and unloading (without going back to zero between measurements), at the same forces. For static forces, and applications in which force is only increased, and not decreased, the effects of hysteresis are minimal. If an application includes load decreases, as well as increases, there may be error introduced by hysteresis that is not accounted for by calibration. For a conditioned sensor, with 50% of the full force range applied, hysteresis is less than 4.5 % of full scale.

## I

**Increase / Decrease Decimal:** Two icons on the Tool Bar do not have corresponding pull-down menus. They are the Increase Decimal and Decrease Decimal buttons. When sensors have been calibrated, units of force will be shown. Clicking these buttons will either increase or decrease the number of decimal places displayed by the software.

## L

**Last Frame (Movie Toolbar Playback Controls):** Positions the recording at the end of the movie (last frame).

**Linearity:** Linearity refers to the sensor’s response (digital output) to the applied load, over the range of the sensor. This response should ideally be linear; and any non-linearity of the sensor is the amount that its output deviates from this line. A calibration is performed to ‘linearize’ this output as much as possible. FlexiForce sensors are linear within +/- 5%.

**Load Calibration (Tools Menu):** The "Load Calibration" command allows you to use the calibration data from a previously-saved file for your current Real-time window. When this item is selected, an ‘Open’ dialog box appears, and the calibration file can be located and opened. Only ELF calibration files (extension *.clb) can be loaded. The Sensitivity setting that was saved with the calibration file will also be loaded.

## M

**Main Menu:** The Main Menu contains important commands you use to perform functions within the software. Some menu commands can be found directly in the toolbar, however, not all commands found under the menu are located on the toolbar. the Main Menu changes, depending where your focus lies. The reason for this difference is because there are some commands that can only be accessed from a Movie Window, and others from a Real-Time Window. For example, if you have two windows open, one a Real-Time Window, and the other a Movie Window, the Main Menu will contain a different set of submenus and commands.

**Main Window:** When you initiate the ELF software program, the Main Window is displayed on your computer screen. The Main Window consists of the Menu Bar, Tool Bar, and Main Status Bar, and may contain one or more Real-time or Movie Windows. The window that is selected is considered the active window or the window that has focus. See "Focus". Only one window can be active at one time, and the title bars of the other windows will be grayed out.

**Menu Bar:** The Menu Bar provides drop-down menus (submenus) used to control the ELF software program. It is located at the top of the Main Window.

**Minimum Requirements:** The minimum hardware requirements that your computer must meet in order to run the ELF software and operate the hardware successfully. The minimum requirements are: Pentium 300 MHz with 64 MB RAM and 5 MB of Hard Drive Space. In addition, a CD Drive, One USB port per ELF handle, and Windows Operating System (one of the following: 2000/XP/Vista). See "Hardware".

**Movie Toolbar (Playback Controls):** This bar is located at the top of the Movie Window, and consists of the movie playback icons and the Save As icon. See "Playback Controls".

**Movie Window:** The Movie Window displays a previously recorded movie. It consists of the display area, scroll bar, the "Movie Toolbar (with playback controls) and the "Movie Window Status Bar".

**Multi-Point Calibration:** Multi-Point Calibration is a method in which at least two known forces are applied to the sensor and then calculated to convert Digital Output into Engineering Units. See "Calibration".

## N

**New (File Menu):** The "New" command opens a new Real-time window, in addition to any other Real-time or Movie windows that are currently open. The new Real-time window becomes the active window when it is opened. If more than one Real-time window is open, the force data will be displayed in all windows, in unison. If the sensor has already been calibrated, this calibration will also apply to the new Real-time window.

**Next Frame (Movie Toolbar Playback Controls):** Plays the recording forward one frame each time it is clicked.

**Number (View Menu):** The "Number" option displays each COM port as numerical values. Each numerical value is color coded to indicate the individual COM ports. As time elapses, the numbers change to indicate changes in force.

## O

**Open (File Menu):** The "Open" command displays the Open dialog box, which allows you to open previously recorded movie files. Only ELF movie files, with the *.flf file extension, can be opened.

## P

**Piece Wise Linear Calibration:** This calibration connects each calibration point and interpolates between the values.

**Play Backward (Movie Toolbar Playback Controls):** Plays the recording in reverse.

**Play Forward (Movie Toolbar Playback Controls):** Plays the recording forward.

**Playback Controls:** The Playback controls are used for movie playback functions. The following functions are available: "First Frame", "Play Backward", "Previous Frame", "Stop", "Next Frame", "Play Forward", and "Last Frame". See "Movie Toolbar (Playback Controls)".

**Port:** See "COM Port".

**Previous Frame (Movie Toolbar Playback Controls):** Plays the recording in reverse one frame each time it is clicked.

**Properties (View Menu):** The "Properties" command opens the Properties dialog box, which allows you to change how the data is displayed on the screen. Any changes made to the Properties will only affect the currently active Real-time or Movie window. The Properties dialog box will also appear whenever you click the right mouse button over a Real-Time or Movie Window. You can select a display option ("Strip Chart", "Column" or "Number"), and also change the "Scale Max", "Scale Min", and "Units".

## R

**Real-Time Window:** A Real-time Window displays the load applied to the sensor as it is happening (in Real-time). The Properties of this display can be changed in the File pull-down menu, or by clicking the right mouse button.

**Recording Parameters:** The recording parameters act as settings for your Movie. Before you record a movie, you should access the Recording Parameters dialog box by going into Record > Settings. Within this dialog box you can select what type of recording you are going to create. Things that can be selected are the amount of frames, speed of recording, any triggering options that need to occur before the recording starts, which sensor will trigger the recording, and the type of units (Pounds, Newtons, Kilograms, etc.).

**Repeatability:** Repeatability is the ability of the sensor to respond in the same way to a repeatedly applied force. As with most measurement devices, it is customary to exercise, or 'condition' a sensor before calibrating it or using it for measurement. This is done to reduce the amount of change in the sensor response due to repeated loading and unloading. FlexiForce sensors are generally repeatable within 2.5% once they have been conditioned. A sensor is conditioned by loading it to 110% of the test weight four or five times.

## S

**Saturation:** The saturation force is the point at which the device output no longer varies with applied force. The saturation force of each sensor is based on the maximum recommended force specified by Tekscan, which is printed on the system packaging or the actual sensor, along with the sensitivity. Sensors are available in three force ranges (Low, Medium, and High), which have specified maximum forces of 25, 150, and 1000 lbf, respectively. The sensor's effective force range (up to the specified maximum) can be altered by adjusting the system sensitivity. Decreasing the sensitivity setting (1 to 20 possible) will increase the force range (displayed as 'Approx Max Range'), and saturation force, of the sensor, and vice versa. It is essential that the sensors do not become saturated during testing. See "Sensitivity" and "Calibration".

**Save As (File Menu):** The "Save As" command will save the current movie with the specific file name and location of your choice. ELF movie files must have the extension *.flf. This menu item can be used to save a movie file under more than one filename.

**Save as ASCII (File Menu):** The "Save As ASCII" command saves the current Movie frame as an ASCII file, with the extension *.csv. Since these files are in ASCII (comma separated value) format, they can be imported into a spreadsheet program (e.g. MS Excel), or they can be opened in a text editor or word processing program (e.g. MS Word) in order to review and manipulate the data.

**Save Calibration (Tools Menu):** The "Save Calibration" command allows you to save your current calibration as a file for future use. When this item is selected, a 'Save As' dialog box appears, and the calibration file can be saved with the specific file name and location of your choice. Calibration files must have the extension *.clb, and can contain up to eight characters. The Sensitivity setting is also saved by the calibration file.

**Scroll Bar (Movie Window):** The Scroll bar is located directly above the status bar in a Movie Window (at the bottom of the movie window below the force data). It can be used to move to any point (frame) in the movie.

**Select Colors (Tools Menu):** The "Select Colors" command allows you to customize the background color, as well as the trace color for each ELF device in your View windows. When this item is selected, the 'Select Graph Colors' dialog box appears. By clicking on either Trace Color or Background Color, a Windows color palette becomes available, and you can select one of the standard colors or create your own custom color for each of the COM ports (sensors). The color you choose will be used for all Movie and Real-time windows, and will be set as the default color. To restore the original color, select the Default All Colors button.

**Sensing Area:** The Sensing area is the silver circle located on the top of the sensor.

**Sensitivity:** Also referred to as "Adjustable Gain". This adjustment sets the data output range from the computer (0 to 100%) to the actual force range output from the system handle. In this way, the usable force range of the sensor can be adjusted (up to the rated maximum force). Sensitivity settings are saved between sessions, and are included with calibration files. Sensitivity can be accessed directly from the Tools Menu or from within the Calibration dialog box.

**Sensor Life / Durability:** Sensor life depends on the application in which it is used. Sensors are reusable, unless used in applications in which they are subjected to severe conditions, such as against sharp edges, or shear forces. FlexiForce sensors have been successfully tested at over one million load cycles using a 50 lb. force. Rough handling of a sensor will also shorten its useful life. For example, a sensor that is repeatedly installed in a flanged joint will have a shorter life than a sensor installed in the same joint once and used to monitor loads over a prolonged period. After each installation, visually inspect your sensors for physical damage. It is also important to keep the sensing area of the sensor clean. Any deposits on this area will create uneven loading, and will cause saturation to occur at lower applied forces.

**Sensor Temperature Sensitivity:** The operating range for FlexiForce sensors is from 15°F (-9°C) to 140°F (60°C). FlexiForce sensor output may vary up to 0.2% per change in degree F (approx. 0.36% per change in degree C). In general, this change will be more significant if you combine high loads on the sensor with high temperatures. For loads of less than 10 lbs., the operating temperature can be increased to 165 °F (74 °C). To ensure accuracy, calibrate the sensor at the temperature at which it will be used in the application. If the sensor is being used at different temperatures, perform a calibration at each of these temperatures, save the calibration files, then load the appropriate calibration file when using the sensor at that temperature. FlexiForce sensors should be stored at temperatures in the range of 15°F (-9°C) to 165°F (74°C).

**Sensors:** The FlexiForce sensor is an ultra-thin (0.005”), flexible printed circuit. It is 0.55” (14 mm.) wide and 9.0” (229 mm.) in length. Sensors are available in three full-scale force ranges: Low (25 lbf ), Medium (150 lbf ), and High (1000 lbf ). The active sensing area is a 0.375” diameter circle at the end of the sensor. The sensors are constructed of two layers of substrate, such as a polyester film. On each layer, a conductive material (silver) is applied, followed by a layer of pressure-sensitive ink. Adhesive is then used to laminate the two layers of substrate together to form the sensor. The ‘active sensing area’ is defined by the silver circle on top of the pressure sensitive ink. Silver extends from the sensing area to the connectors at the other end of the sensor, forming the conductive leads. The sensor acts as a variable resistor in an electrical circuit. When the sensor is unloaded, its resistance is very high (greater than 5 Meg-ohm); when a force is applied to the sensor, the resistance decreases. FlexiForce sensors have been successfully tested at over one million load cycles using a 50 lb. force. See also "Sensor Life / Durability".

**Settings (Record Menu):** Settings: brings up the Recording Parameters dialog box, which allows you to change the current recording parameters. Under ‘Recording Type,’ there are three possibilities that may be selected. See "Recording Parameters".

**Start (Record Menu):** The "Start" command is used to make a recording (movie). When Start is selected, the software begins recording a movie of the current Real-time window data using the settings that have been selected (see Settings menu item). When data is being recorded, the Recording In Progress message will appear (shown below), and the Recording On icon (on the Main Tool Bar) will become active (the red circle will become grayed out, and the square "Stop" button -- black color -- will become visible). If ‘Triggering’ is in effect, and Record is selected, the Waiting for Trigger message will be displayed until the trigger force is reached. Movies created by the ELF system are stored as *.flf files.

**Status Bar (Main):** The Main Status Bar provides the user with feedback about what is happening inside the ELF software. It will either say ‘For Help, Press F1’, or will give a description of whichever Toolbar icon is under the cursor. The Main Status Bar is located at the bottom of the Main Window.

**Status Bar (Movie Window):** The Movie Window Status Bar is located at the bottom of the Movie Window, and displays the Frame count (the current frame number vs. the total number in the movie).

**Status Bar (View Menu):** The "Status Bar" option is used to display or hide the Movie and Main Status Bars. These status bars can be toggled by clicking this menu item on and off. If a Real-time window is active, this menu item affects the Main Status Bar. If a Movie window is active, this menu item affects the Movie Status Bar.

**Stop (Movie Toolbar Playback Controls):** Stops playback.

**Stop (Record Menu):** The "Stop" command will cause the software to stop recording the active Real-time window, even if the correct number of movie frames (as selected in Settings) have not yet been recorded.

**Strip Chart (View Menu):** The "Strip Chart" option is the default display mode, where force value is displayed on the Y-Axis and elapsed time is displayed on the X-Axis.

## T

**Temperature Sensitivity:** See "Sensor Temperature Sensitivity".

**Threshold:** Refers to a value within the Recording Parameters that is set by the user. The Threshold may be set for each individual COM port, so that each sensor has a different Threshold. This may be used in combination with the Trigger Force value to begin recording when force is exerted on a specific sensor. See "Recording Parameters".

**Tile (Window Menu):** The "Tile" command arranges multiple windows in an overlapped fashion, either vertically or horizontally.

**Toolbar:** The Toolbar provides some of the same options as the Menu Bar, but with icons replacing drop-down menus. It is located directly below the Menu Bar, at the top of the Main Window. Note that not all items in the Menu Bar have a corresponding icon on the Tool Bar.

**Toolbar (View Menu):** The "Tool Bar" option is used to display or hide the Movie and Main Tool Bars. These tool bars can be toggled by clicking this menu item on and off. If a Real-time window is active, this menu item affects the Main Tool Bar. If a Movie window is active, this menu item affects the Movie Tool Bar.

**Trigger Force:** See "Triggering".

**Triggering:** Refers to the Recording Parameters dialog box. This dialog box allows you to 'trigger' the start of a recording based on a force value. If you enter a value in the 'Trigger Force' field, and select the appropriate measurement units, recording will not begin until that force is exerted on the sensor. Enter a zero in this field to disable 'triggering'. Only one Trigger Force value may be entered, and will apply to all sensors being used for testing. See "Recording Parameters".

## U

**Uncalibrate (Tools Menu):** The "Uncalibrate" command removes the sensor's calibration data. When this item is selected, a dialog box will appear, giving the option of canceling the Uncalibrate operation. Uncalibrate does not affect the Sensitivity setting. See "Sensitivity".

## W

**WELF:** The Wireless ELF System.

## Z

**Zeroing Preload (Tools Menu):** The "Zeroing Preload" command modifies the calibrated data to correct for residual pressure (referred to as the 'Offset Load') on the sensor at zero load. This operation is useful if the sensor is under some load for the entire duration of the recording, or if the sensor must be secured in place by hardware which would cause load to be detected by the sensor. The raw data is not affected by the Zeroing Preload function, but an extra calculation is performed when converting the raw data to calibrated data. If the sensel is reading raw pressure, it is set at zero raw before the calibration scale factor is applied. Zeroing Preload is recommended only for single point calibration and may increase error when using a multi-point calibration.